THE

ELECTRICAL REVIEW.

VOL. LII. JANUARY 16, 1903. No. 1,312.

"ELECTRICAL REVIEW."

Vol. LII.] CONTENTS: January 16, 1903. [No. 1,312.

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THE

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1903 Edition

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THE DYNAMO BUSINESS AT THE CLOSE OF 1902.

AN article which we published on this subject about two two years ago had a more satisfactory story to relate than can be recorded for the year 1902.

Since the very beginning of our industry, the manufacturers of electrical machinery have had more to risk as a body, and have obtained less in return, than those engaged in any other branch of the business, and once more their prosperity of a year or two ago seems likely to be checked—in fact, has already been checked—by the present state of trade.

This is very much to be regretted, more especially when it is remembered that other manufacturers whose trade is closely allied to—in fact, dependent upon—the dynamo building business, have reaped a harvest of no mean order. Cable makers, high speed engine builders, suppliers of the various raw materials which go towards building up electrical machinery, have had little cause to complain, whilst those engaged in the manufacture of heavy electrical machinery, who are to a large extent the backbone of the industry, have never experienced any continued prosperity. It is difficult to lay the blame altogether at their door.

Two years ago the supply of orders for dynamo manufacturers was very plentiful, and the demand exceeded the supply to such an extent that foreign makers were able to step in and obtain a large portion of our business without making themselves seriously felt. To-day our Continental friends are more anxious than ever to obtain our orders; but we cannot spare them, and the result is that comparatively little work is going out of the country. The efforts of foreign rivals are, nevertheless, successful in increasing competition and reducing profits to a minimum. This country can to-day produce more electrical machinery than there is at present demand for, and whilst matters will, no doubt, settle down in time, the present state of affairs cannot be regarded as altogether satisfactory.

There are three different respects in which we may hope for an improvement in the near future. Firstly, by an increase in the demand; secondly, by some of the less up-to-date shops withdrawing their competition; and, thirdly, by some of the larger firms in this country (who have hitherto been handling the surplus productions of Continental and American shops) commencing to manufacture in our midst, and consequently selling more with a view of making a profit than of obtaining orders for hungry Continental shops.

The outlook, so far as expansion of our industry is concerned, is on the whole satisfactory. The proposed electrification of the suburban portions of many of our leading railways, the conversion of our tramway systems to electrical working, and the setting to work of many large power

distribution stations, are all likely to bring work, directly or indirectly, to the manufacturing shops.

In addition to this, one notes with satisfaction the way in which private works—shipyards, collieries, &c.—are gradually adopting electrical working, and this with much less hesitation and doubt as to ultimate results, than was the case a few years ago.

Those who intend, however, to participate in the benefits introduced by the wider adoption of electrical working, and to compete with the many up-to-date shops now existing in this country, will have, without doubt, to bring themselves into line with their more progressive competitors.

Their only alternative—if orders depend on open competition—will be a withdrawal from this branch of the business. No doubt a continuation of the present state of affairs for another year or two would be beneficial in weeding out those not organised for competitive working, and in this respect good may yet come out of what appears at present to be evil.

The third point is sufficiently obvious to require no explanation. The British Westinghouse Co., for instance, are now ready at Manchester (according to their chairman's remarks the other day) for dealing with their orders without drawing from America. Then again, the British Thomson-Houston Co. will also presently be in a position to manufacture at Rugby all that they require. Firms of this description will then be working under the same conditions as other manufacturers in this country, and their competition will be on the same footing.

Whilst our manufacturers are at present struggling in the midst of this severe competition, many of them have to face the further difficulty of dealing with an increasing number of types of machinery for meeting the requirements of the market. Multiphase generators for power transmission purposes have firmly established themselves, and multiphase motors have also proved themselves suitable for ordinary works' use. It cannot be said, however, that continuous current machinery can be at present, or is likely to be in the near future, relegated to the scrap heap; on the contrary, it is likely to hold its own against the newer systems for many classes of work. Two different types of machine have, therefore, to be made in place of one, and this is, no doubt, an objection, more especially for manufacturing shops of medium size.

In addition to this some of our manufacturers are turning their attention towards building alternators suitable for direct coupling to steam turbines. In all probability direct current dynamos are not likely to be widely adopted for direct coupling to turbines, due to commutator troubles, but the future will no doubt see a wider adoption of alternators of large size direct coupled to this form of prime mover.

In our article dealing with the position of dynamo makers at the close of 1900, we dealt briefly with the possible difficulties which smaller electrical manufacturers would have in competing with the large establishments recently organised in this country. It still remains to be seen whether some of the larger firms will have any material advantage over the better organised smaller ones.

In some respects they, no doubt, will have some advantages in handling schemes, for instance, which are growing larger in size almost every day, and which a small firm would perhaps find it impossible to build.

In certain other respects they may, on the other hand, be at a disadvantage as compared with well-organised small firms.

In concluding these few remarks, attention might be drawn to the practice, which seems on the increase—no doubt brought about by the keen competition existing—of manufacturers taking payment for work done in the form of debentures or shares in the purchasing company. It is very doubtful whether a manufacturing concern should make a practice of locking up its working capital in this manner, and whilst limited investments in this direction may be advisable under certain circumstances, the fact cannot be overlooked that this very practice has brought German manufacturers into overwhelming troubles, from which they are likely to take some time to recover.

Manufacturing on a large scale undoubtedly requires the assistance of a finance department, but it were far preferable that this should take the form of a separate company, as in the case of one large American firm, than that the use of money intended for manufacturing purposes should be invested in new concerns, whose shares will at the best be unsaleable for some years to come. This method of obtaining work for the shops is likely to show a profit on the balance-sheet for the time being, but it may lead to trouble if the paper securities do not turn out to be so valuable as was expected, or in the event of circumstances requiring the immediate sale of securities which are never likely to have a very free market.

On the whole the outlook is encouraging, but it is to be feared that changes will have to be brought about on the manufacturing side of our business before this important branch can be said to be in a really satisfactory condition.

Engineering as a Profession.

An interesting series of articles entitled "Our Sons, and their Start in Life," is running in the columns of the *Guardian*, and No. IX. deals with the engineering profession. We are told that "success can only be looked for as the reward of honest and strenuous labour," and that "the points of character which distinguish a successful engineer are decision, courage and self-reliance, a sound common-sense . . . . capacity for hard work, and tact in the management of men." A good constitution is also specified. It seems, therefore, that to succeed as an engineer one must possess just those qualities which would lead to success in almost any professional career.

The author refers to the defects of the public school system of training, even on the "modern side"; the "ancient side," as we may call it, is ignored, being presumably unspeakable. After sketching out a very appropriate school training, the author deals with pupilage and apprenticeship, and recommends a three-years' course at a good engineering college as a preliminary, followed by a year or two in engineering works. Afterwards the young engineer "must be contented for some years to work hard for small remuneration." Unfortunately, almost all young engineers who have been through a college course seem to think that these few years should be skipped, and that they should immediately drop into positions of responsibility and affluence. They are destined to be disappointed in the majority of cases; but few attain to the "£1,000 a year or more" hinted at by the author, and though some do find themselves prematurely occupying important posts, it is good neither for them nor for the undertakings of which they are in charge. *Festina lente* is a good motto; let the

young engineer cherish his ambition—that is good; but let him not seek to rise to eminence (as some have done) without the experience, which is essential to honourable and enduring success.

The author's suggestions and advice for the benefit of his readers, with regard to the training of engineers and the various openings for their energies, are sagacious and versatile, and the article is well worthy of the attention of those interested in these matters.

The Cooper-Hewitt Inventions.

The devices, of which we publish an illustrated description on another page, cannot fail to arouse the interest of our readers. The Cooper-Hewitt lamp is, it is true, hardly a novelty, as we have published articles on the subject in previous years; but this has been developed considerably, and now appears to be in a form suitable for practical use. The extraordinarily high efficiency which has already been attained—stated as 3·3 candles per watt under favourable conditions—is comparable with the five candles per watt which represents 100 per cent. efficiency; the coolness of the tube when emitting an intense luminous flux appears to bear out the claim, though, owing to the wide difference between the quality of the light and that of all ordinary standards, the true value of the candle-power may be a matter of opinion. The clever and extremely simple starting device employed is worthy of its association; the inductance coil may be left in circuit if desired, as it consumes only a trifling amount of power. Thanks to the efficiency and simplicity of the lamps, and the possibility of running them in series without risk of interruption, they should have an excellent chance of utilisation in the District Railway tunnel, and for various other purposes where the quality of the light is of no great moment.

The Hewitt converter commands our admiration. Physicists have for years experimented on the flow of electricity through gases, and observed the laws which govern its operation; but it has been reserved to Mr. Cooper-Hewitt to at one stroke bring this subject right into the midst of heavy electrical engineering, railway working and power transmission. At first sight it might seem a somewhat rash proposal to pass heavy currents through rarefied gases enclosed in glass bulbs—too much like treading on eggs; but second thoughts, and, still more, actual trials, will readily dissipate one's doubts. What will be the effect of the satisfactory development of this new stationary rectifier?—we refrain from using the word "static" in this connection; of all misnomers, surely this is one of the worst. The fundamental change in sub-station equipment will be the supersession of rotary converters and motor-generators—no small gain. But half the waves of the alternating current are omitted; to make use of these we suggest that a second set of transformers be installed, utilising the otherwise dropped waves, and perhaps both sets could be reduced in size, so that the total capital outlay would not greatly exceed that of the existing type of transformer equipment. If this were not done, it seems that only half the available output of the generators and cable lines would be utilised, a far more serious consideration than the cost of motor-generators. The direct current voltage obtained, it appears, is about 14 volts lower than the virtual voltage of the alternating current, measured between the neutral and outers. The maximum safe pressure is 1,000 volts, which is about as high as is likely to be used in direct current railway working.

It must not be forgotten that the device is as yet only in course of evolution, but it has great possibilities, and may become an important factor in electrical power transmission, besides being of great use in many ways, such as the supply of direct current motors from three-phase supply mains in works, charging batteries from A.C. mains, &c. Having seen it actually in operation, we were strongly impressed with its performance, and we shall look forward with interest to its further development.

MOTOR WITH EXTERNAL ARMATURE.

The accompanying illustrations represent a new type of motor, which has been patented by Mr. H. A. Mavor, of Messrs. Mavor & Coulson, Ltd. In fig. 1 the motor is shown applied to driving a propeller fan.

In the early seventies Lord Elphinstone devised a continuous current machine with internal magnets, the armature being rotated between the internal magnets and external magnets of the then ordinary double-limb type. Since then various changes have been rung on this

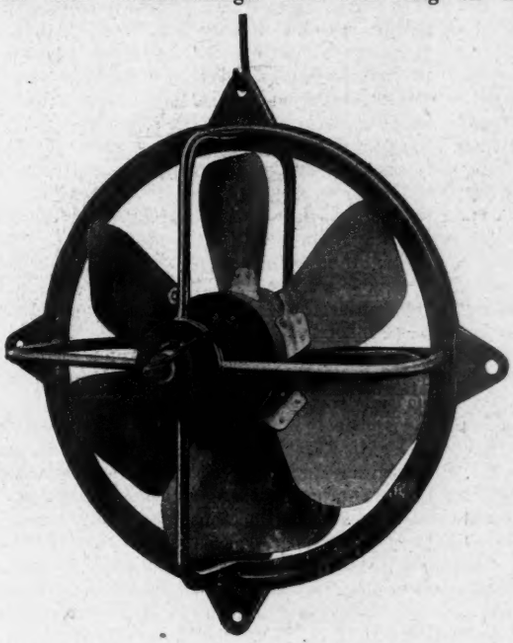


Fig. 1.

arrangement, including, amongst others, the Joel motor for electric automobiles, in which the armature overhangs an internal magnet. Most of these arrangements have, however, been more or less unsatisfactory, owing to difficulties of manufacture, or inequality of wear in the bearings, owing to the overhung armature.

The most serious difficulty has been in the provision of proper lubricating arrangements, which must not result in

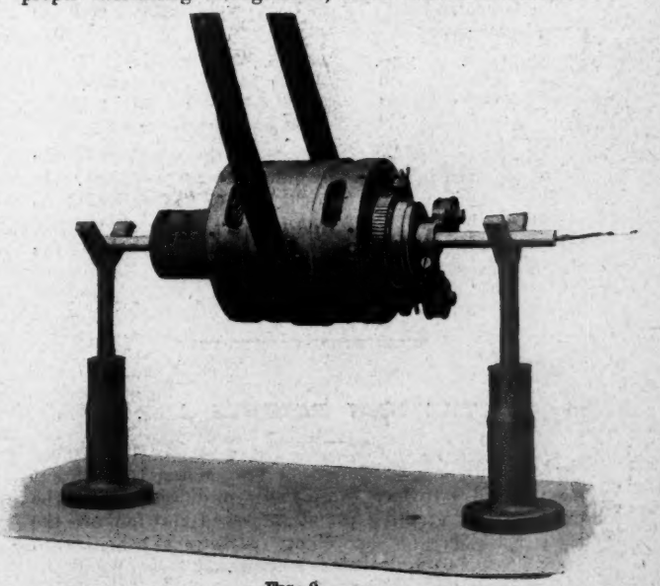


Fig. 2.

the discharge of lubricant to the inside of the armature. These difficulties have been got over in an ingenious manner in the machine illustrated. The armature disc stampings are similar in form to the stampings of the stator of a polyphase motor, the windings being inserted radially from wthiñ. The magnet is a + shaped steel casting, with wire

wound on two limbs and with two consequent poles, the wire being held in position by pole-shoes attached to the magnet after the coils are in place. This magnet is mounted on a hollow stationary shaft, which carries the conductors from the outside to the magnet winding. On this stationary shaft is hung the external armature with a running bushed bearing at each end. The running bush is supported on the end plate carrying the armature discs and winding, and is formed at the inner end with a groove and projection, the groove communicating by openings with the outside of the running bush, over which is placed an oil-catching vessel. At the outer end of the running bush is fixed a flange, dipping below into the oil in the catcher reservoir. From this running disc the oil is thrown on to a stationary disc, forming part of and communicating by grooves on its inner face with channels in, a fixed bush attached to the stationary shaft. The oil thus circulates from the catcher reservoir by the running disc, the stationary disc, and grooves in the stationary bush to the running bush, being thrown off again at both ends of the running bush into the oil catcher reservoir.

The advantage of the general arrangement of this machine for driving a propeller fan is very evident. The armature, in which the greater part of the heat due to electrical and magnetic losses is generated, is directly exposed to a cooling current of air, the blades of the fan being attached directly to the periphery of the armature. The magnet is reduced in weight, and the armature itself is not materially heavier than an ordinary armature of the same power running at the same speed.

Although this machine has been specially designed for driving propeller fans, and makes a very compact and efficient arrangement for this purpose, it has also been adapted to other purposes where lightness and ease in fixing are desiderata. The whole machine being mounted on a straight stationary bar, can be fixed in any position —for example, to take the place of a countershaft driving machine tools or other machinery; the armature itself may be used as a belt pulley, as shown in one of the accompanying illustrations, fig. 2 (p. 87).

Very exhaustive tests have been made of the efficiency of this machine. It will be seen that such tests are very easy to make, no brake being required. All that is necessary is to balance the stationary shaft on knife edges, to set the fan rotating, and to measure the pull required to keep the shaft from rotating. This measures the total reaction between the magnet and the moving armature, and eliminates all losses whatever, the torque applied to the stationary shaft being a direct measure of the power of the motor.

The tabulated results of the tests of a ½-B.H.P. motor are given below :—

Speed.	Volts.	Amperes.	Efficiency.
534	210	3·61	62 per cent.
486	192	3·32	63·5 "
516	220	3·87	62 "

The overall external dimensions of the armature of the motor described in the above tests are 10 in. × 18¼ in.

There are many cases for which such motors would be highly suitable, and Mr. Mavor is to be congratulated upon his neat solution of the many difficulties which arise in the design of external-armature motors.

THE NEW PATENTS ACT.

The Patents Act which became law on the 18th of last month, will introduce considerable modifications in the procedure for granting patents, and will also improve the legal machinery for compelling recalcitrant patentees to grant licences to work their inventions.

Considering in the first place the part of the Act relating to the granting of compulsory licences, there can be no doubt that the provisions in this Act are a great improvement on those in the last Patent Act where the granting of licences was left in the hands of the Board of Trade with no power to enforce its decisions. In future the Board of Trade will be able, if it fails to arrange the matter between the parties, to refer the petition to the Judicial Committee of the Privy Council. Where any such petition is referred by the Board of Trade to the Judicial Committee, and it is proved to the satisfaction of the Judicial Committee that the reasonable requirements of the public with reference to the patented invention have not been satisfied, the patentee may be ordered by an order in Council to grant licences on such terms as the Committee may think just, or, if the Judicial Committee are of opinion that the reasonable requirements of the public will not be satisfied by the grant of licences, the patent may be revoked by an order in Council. A patent, however, is not in any case to be revoked before the expiration of three years from the date of the patent. The Act contains special provisions for preventing foreigners taking out patents in the United Kingdom and refusing to work them or to grant licences, with the view of prejudicing existing industries or preventing the establishment of new industries in this country.

These precautions against the use of patents to interfere with and obstruct industry are necessary as a last resort, but we doubt whether it will often be necessary to make use of these provisions of the Act. The number of anti-patriotic or Anglophobe patentees, who will refuse a good offer for their invention for the purpose of striking a blow at perfidious Albion must, we should think, be very small indeed. We believe there were not more than half-a-dozen applications for compulsory licences under the old Patent Act, and this was not altogether due to the fact that the machinery for obtaining the licence was inadequate.

Coming now to the part of the Act dealing with the examination for novelty, we have here a much more important change in our patent procedure, and it will be interesting to endeavour to forecast to what extent the inventor and the public are likely to be benefited by it.

Under this new Patents Act, every application for a patent will be referred forthwith to an examiner, who shall make an investigation for the purpose of ascertaining whether the invention claimed has been wholly or in part claimed or described in any specification (other than a provisional specification not followed by a complete specification) published before the date of the application, the search being confined to British specifications coming within the last 50 years.

If on investigation it appears that the invention has been wholly or in part claimed or described in any such specification the applicant is to be informed, and he may within such time as may be prescribed amend his specification.

When the Patent Office is satisfied that no objection to the specification exists, on the ground that the invention claimed has been wholly or in part claimed or described in a previous specification, the specification will be accepted.

But if the Patent Office is not satisfied reference to prior specifications considered to anticipate the whole or a part of the applicant's invention, will be inserted in his specification.

An appeal will lie from the decision of the Comptroller of Patents to the Law Officer.

The period of provisional protection is to be reduced from nine to six months.

Such are the main provisions of the new Patents Act with reference to examination of inventions for novelty. It will be observed that the Patent Office has no power to refuse any application for a patent. It merely makes a search and communicates the result of the search to the applicant who may withdraw his application or proceed with it as he pleases. If he proceeds with it he has to pay an additional fee not exceeding £1. If he withdraws, he only loses the £4 he paid for his application and his complete specification.

The part of the Act relating to compulsory licences came into force with the passing of the Act, but the part relating to the examination for novelty is held in abeyance at the discretion of the Board of Trade, and is not likely to come into force within the next two years.

The procedure in granting patents under the new Act will somewhat resemble the German and United States system, but with this important difference that there will be no power to reject patents for inventions which are not new. The resemblance is closer with the Swiss system where there is also no power of rejecting patents which are not novel, but

in the Swiss system there is no power to insert references to prior specifications. Our new precedure is practically the same as a proposal which was made by Mr. Lloyd Wise some 30 years, and which has since that date been strongly advocated by our contemporary *Engineering*. In a recent leading article on the new Patent Act, our contemporary concludes that the new procedure is beneficial both in the interests of inventors and in the interests of the public. Applicants who had been anticipated would be saved useless expenditure. Nor, says *Engineering*, can applicants, under the Lloyd Wise system, suffer by the erroneous judgment of the examining authorities, but our contemporary does not consider that the public might suffer by the erroneous or perverted judgment of an applicant who persisted in completing his patent after he had been shown clearly that his invention was old.

We have quoted these arguments of our contemporary because they appear to represent the most prevalent opinions on patent matters among experts in this country. Shortly stated, the position amounts to this, that it is better that any number of patents should be granted for inventions that are not new, and therefore public property, than that one real inventor should be refused his patent. According to this view, the property of the public must be sacrificed in order to preserve the property of the inventor. But, says the advocate of the Lloyd Wise scheme, the public are protected by having the facts put before them in the reference. Is this, however, as good protection as the rejection of applications for patents when the inventions are not novel? The patentee, though his invention may be old and, therefore, public property, possesses a legalised monopoly, and can enforce this monopoly against anybody who is not prepared to risk an expensive law suit. There is always a large number of small manufacturers and traders who would rather pay a moderate royalty than run this risk.

Sir Edward Fry's Committee found that upwards of 42 per cent. of the patents at present granted in England have been wholly or partly anticipated, that is to say, about one out of every two patents granted are for machinery and processes which are already the property of the public. But, say the advocates of the *laisser faire* system, this is necessary in order to stimulate real invention, because if the genuine inventor knows that he runs the risk of having his patent refused by a blundering official examiner, he will not apply for a patent. The experience of the United States and Germany shows that an effective system of official examination does not discourage invention, since the applications for patents are quite as brisk in these countries as in England.

In our opinion the insertion of references will have very little effect in suppressing the worst type of bogus patentee. In fact, the ordinary inventor without any fraudulent intention has the greatest difficulty in seeing that the most obvious anticipations are the same as his own invention, and looks upon the most insignificant differences as of essential importance.

The insertion of references will probably make a patent less saleable, but that will not affect those who intend to work their own bogus patents, or to use them for blackmailing purposes. The working of the new Patents Act will enable us to judge better to what extent the reference will be effective in stopping bogus patents.

These considerations make it highly probable that the new Patents Act will not be so beneficial to the interests of the public as an Act which would have empowered the examining authority to reject applications for inventions that were not new. The risk of refusing a patent for a genuine invention might be sufficiently minimised by instructing examiners to give doubtful cases the benefit of the doubt. A practical proof that this danger is exaggerated is the fact that there is no general agitation either in the United States or in Germany for the abolition of effective examination for novelty. Quite recently the German Trades Congress declared emphatically in favour of the retention of the German system of examination, the only amendment they asked for being that the examiners should not be allowed to decide whether a difference between two inventions constituted a valuable technical advance or not.

Let us now consider whether the new Patents Act will be beneficial to the interest of the genuine inventor. Will it increase the value and saleability of his patents? Apart from its inherent commercial value, which has nothing to do with Patent Law, the saleability of the patent depends on the probability of the invention being novel. Under the old system of granting patents in this country, 50 per cent. of the patents granted are wanting in novelty. This percentage, we believe, will only be very slightly reduced, if at all, when the new Act comes into force. The benefit to the inventor will, in this respect, be very small indeed compared with what would result from a system of examination, which might very well weed out 80 per cent. of the bogus patents.

Some few inventors may be saved the further expense of proceeding with the protection and working of an invention which the results of the search of the official examiner have shown not to be novel. It remains to be seen how many will be stopped in this way.

A reference may often act unfairly to the detriment of a patent which has been only partly anticipated. The novel part of the patent may be of the greatest value, but the public, who are not all skilled in patent matters, may jump to the conclusion that whole patent is bad.

It is only as a step in the right direction towards an effective system of examination that the Patents Act, 1902, can be regarded as satisfactory. Much may be learned by comparing patent statistics under the new Act and under the old Act. We shall then be able to learn by actual experience whether the new Act will stimulate invention, protect the public, and benefit the true and first inventor.

We anticipate that one indirect result of the new Patent Act will be the abolition of the provisional specification. Provisional specifications are explicitly excluded from the material to be searched through by the examiner, consequently if A files a provisional specification of an invention, and B files a complete specification of the same invention a month after, no reference to A's prior specification will be inserted in B's specification. A therefore will lose whatever benefit is to be derived from the new system of examination if he chooses to file a provisional instead of a complete specification of his invention.

Regarded as an experimental Act to pave the way to an effective system of examination, the Patents Act, 1902, is an epoch-making change in our Patent Law, but considered as the permanent Patent Law of England, it is so little of an advance on the old *laisser faire* system that it is very doubtful whether it is worth the extra cost to the taxpayer.

THE HEWITT MERCURY VAPOUR LAMP AND RECTIFIER.

On Friday last week a demonstration was given at Westinghouse Building, Norfolk Street, W.C., of the mercury vapour lamp invented by Mr. P. Cooper-Hewitt, of New York, and of its offspring, the Hewitt rectifier or converter. The former has been from time to time the subject of descriptive articles in the Electrical Review (Vol. xlviii., p. 906; Vol. xlix., p. 660; Vol. l., p. 240); it will suffice, therefore, to mention that the lamp consists essentially of an exhausted glass tube, containing a small pool of mercury at one end and an iron electrode at the other. The iron is used as the anode, the mercury as the cathode, and conduction takes place through the mercury vapour, rendering the latter intensely luminous. The light emitted is perfectly steady, and proceeds from practically the whole surface of the tube; it is of a bluish-green colour, exceedingly unpleasant æsthetically, but we can quite believe that the claims made on its behalf—that it is pleasant and congenial for working under—are well founded. The lamps can be made of any desired shape or size, from ½ in. diameter and 3 in. length to 3 in. diameter and 12 ft. length; the candle-power obtained can be varied from 16 c.p. to several thousand, as desired, by suitably proportioning the tubes. The lamps work in series or parallel, on direct-current circuits, at any voltage between 50 and 500 volts, and allow of a variation of 10 per cent. in the pressure; the current may be from ·2 to 20 amperes.

The efficiency claimed is about two candles (spherical) per watt, rising to more than three under favourable conditions; of course, the light being totally different in quality from the ordinary standards, Prof. Fleming's remarks on the measurement of hetero-chromatic sources of light apply here with peculiar force.

The temperature of the glass does not exceed that of an ordinary glow lamp. The life of the lamp is indefinite, as it can be cleaned after, say, 1,200 hours, and is then as good as new.

The most interesting feature of the recent demonstration was the fact that it was intended to illustrate the possibilities of the Hewitt lamp for illuminating the District Railway tunnel. For this purpose, the quality of the light

Fig. 1 herewith shows the appearance of the lamp when in use, while fig. 2 shows two lamps in series, with their starting apparatus, &c., as mounted for demonstration purposes.

The starting device consists of nothing more than an inductance coil in series with the lamp. In order to start, this coil is connected through a resistance across both poles of the supply circuit; the connection is then interrupted, when the "extra current"—or, rather, extra E.M.F.—due to the discharge of the inductance coil, breaks down the resistance between the vapour and the mercury cathode, and the lamp lights up. To assist this action, a metal sleeve connected with the anode is fixed outside the tube, close to the cathode.

The Hewitt converter is a natural development from the

FIG. 1.

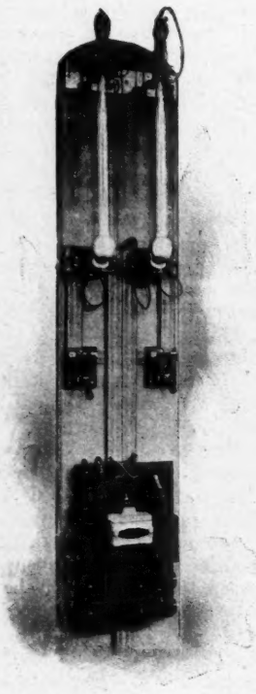


FIG. 2.

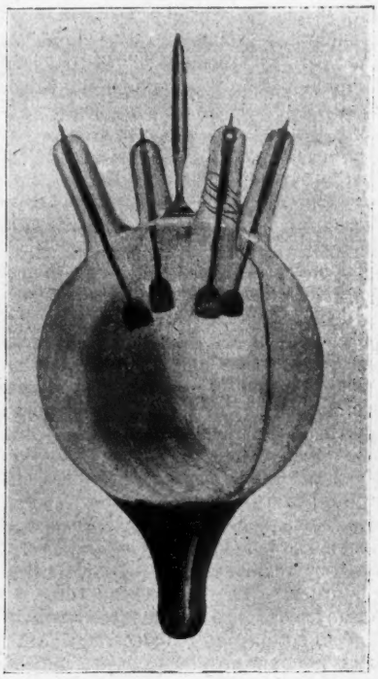


FIG. 4.

is quite immaterial; efficiency and cheapness of installation are the essential factors, and these, it is believed, will be secured by the use of this system to a pre-eminent degree. It is maintained that the lamp is also suitable for out-door lighting of all kinds, for office work, and for lighting

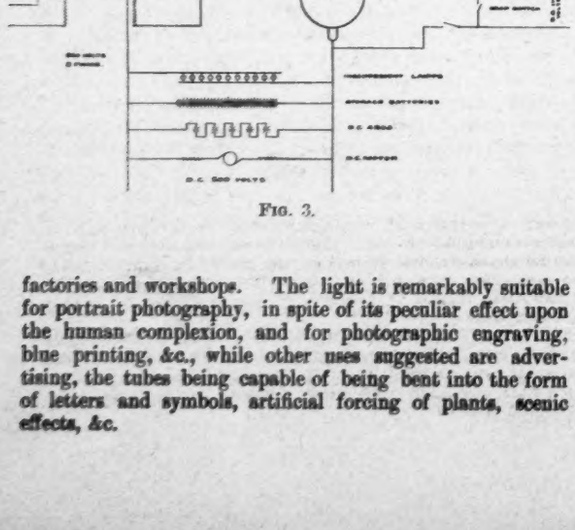


FIG. 3.

factories and workshops. The light is remarkably suitable for portrait photography, in spite of its peculiar effect upon the human complexion, and for photographic engraving, blue printing, &c., while other uses suggested are advertising, the tubes being capable of being bent into the form of letters and symbols, artificial forcing of plants, scenic effects, &c.

mercury vapour lamp, and is admittedly at present in an experimental form. Its operation depends upon the fact that the current can flow *in one direction only*, through the mercury vapour, so that, in the case of an alternating current, half the alternations are cut off, leaving only those in which the mercury acts as cathode, as in the aluminium electrolytic rectifier. Thus from single-phase current an intermittent direct current is produced, and from polyphase current an almost uniform direct current, by means described below. There is a constant drop of 14 volts in the apparatus, and as it can be used for all pressures from 100 to 1,000 volts, the efficiency for the higher voltages is very high—98·6 per cent. at 1,000 volts. Currents up to 100 amperes can already be dealt with, and any number of converters can be operated in parallel.

The diagram, fig. 3, shows the arrangement of the connections with polyphase currents. After transmission at high pressure, if need be, the current is transformed down to a voltage not much in excess of the direct current voltage required; the transformers are connected star-wise, and leads from the three outer terminals are taken to three of the anodes shown in the bulb of the converter, fig. 4. The pool of mercury forming the cathode at the base of the bulb is connected with one of the direct current bus-bars, the other of which is joined to the neutral point of the star. The fourth anode shown is used for starting the converter by means of a direct current; once started, the action is maintained, each of the three-phase anodes coming into operation in cyclic order, so that the flow of current in the direct current

circuit not only never ceases, but is subject to but little fluctuation. The apparatus was shown converting three-phase to direct current, supplying glow lamps and a direct current motor; the rectified current can be used for charging accumulators and for electrolysis, D.C. arc lighting, &c., and it is thought that the apparatus will be especially useful in place of rotary converters for electric railway working, thus abolishing moving machinery of every kind from the sub-stations, and diminishing to the utmost the need of attendance. The alternating current may also be led into the cars at high pressure, Hewitt converters being carried on the cars to convert to D.C. for the motors.

Although the apparatus is as yet somewhat crude, its latent possibilities are obviously great, and its evolution will be watched with the keenest interest.

WIRELESS TELEGRAPHY IN FRANCE.

By E. GUARINI.

(*Concluded from page* 1050, *Vol.* 51.)

We now come to Marconi's remarkable experiments. In March, April and June, 1899, the English Wireless Telegraph and Signal Co. established communication between Wimereux, on the French Coast, and South Foreland, on the English Coast—a distance of 46 km., with antennæ of 45 metres at first and 27 metres afterwards (this last height seemed insufficient to secure good working, and the antenna was doubled by a second conductor connected with the first in parallel). The Wimereux station was situated on the sea coast, and that of South Foreland on a cliff 80 metres above the sea level. A third station was installed some time ago on the lightship *Goodwin*, and regular communication was kept up between this ship and the coast through the South Foreland station at a distance of 19 km. The height of the antenna of the *Goodwin* was about 24 metres; the vessel, the masts and the shrouds were entirely of iron.

The three stations above-mentioned were normally syntonised in such a manner as always to ensure communication between the *Goodwin* and the coast. The latter station could not communicate with Wimereux on account of the distance (49 km.), the interposition of Cape Gris Nez, and the shortness of the *Goodwin* antenna (24 m.). Provisional installations were also made on board the despatch boat *Ibis* and the transport *Vienne*. These two vessels were furnished with antennæ of 22 and 31 m. respectively.

The experiments may be divided into three categories:—Experiments in simple communication in open spaces; experiments in simple communication with obstacles intervening; experiments in syntonisation. During all these experiments the rate of transmission was about 40 letters per minute.

Experiments in Simple Communication in Open Spaces.—The communications from the South Foreland to Wimereux and the *Goodwin*, and *vice versâ*, were in every case very satisfactory in all weathers (fog, wind, rain and storms).

The communications between the moving stations (the *Ibis* and the *Vienne*) and the three stations mentioned above, were also very good, both when the ships were in motion and when they were at rest.

The maximum distances attained were as follows:—The *Ibis* (22 m.), the *Goodwin* (24 m.) to 20 km.; the *Ibis* (22 m.), South Foreland (45 m.) to 25 and 30 km.; the *Vienne* (31 m.), South Foreland (37 m.) to 48 km.

Between the last two stations communication was realised in one direction (the receiver being on board the *Vienne*) to as great a distance as 52 kilometres. The receiver at South Foreland ceased to act at 48 km. Marconi gave the following explanation of this fact:—The mechanical sensitiveness of the South Foreland receiver had been regulated by him for communication with Wimereux at 46 km. distance, but was insufficient for a much greater distance, whereas on board the *Vienne* this sensitiveness had been regulated for the maximum distance.

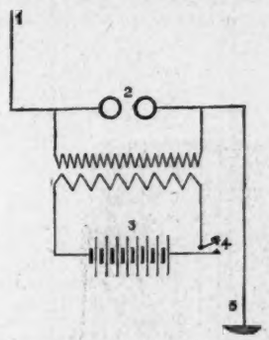
Experiments in Simple Communication with Obstacles Intervening.—The *Ibis* being stationed near the red buoy (No. 2 to the east of Cape Gris Nez) at 19 km. from Wimereux (45 m.), it was possible to exchange messages between the two stations, notwithstanding the intervention of the mass of land forming Cape Gris Nez, the highest point of which is 100 metres above the sea level. The *Vienne* was in dock in the harbour of Boulogne; communication was established between her and Wimereux (5 km.), with antennæ of a height of 12 m. on board the *Vienne*, and 37 m. at Wimereux, notwithstanding the interposition of the Crèche, a height of about 75 m., and all the electric mains of the harbour at Boulogne.

Experiments in Syntony.—A complete programme of experiments had been prepared with the object of verifying the following facts:—

1. Given three stations A, B, C, placed in the zone of mutual action, A and B being tuned alike and differently to C, C cannot receive the messages sent between A and B, when its distance from A and B exceeds a certain limit to be determined; nor can A and B receive the messages transmitted by C, and the reception of the messages exchanged between them is not disturbed by the transmissions from C.

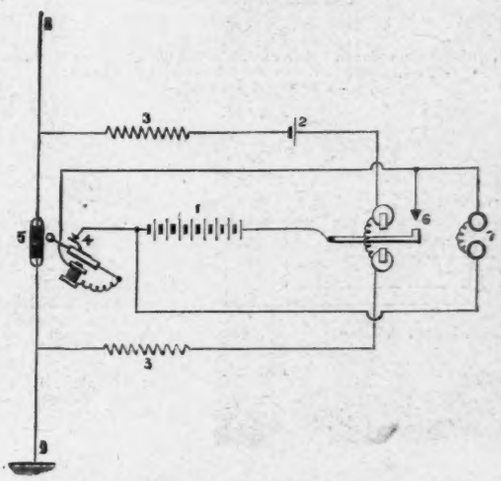
2. The three stations having been tuned in this manner, it is possible to modify one of the stations A or B, A, for instance, so as to place it in syntony with C, without touching B or C; B then being in the same relation with A and C as C had previously been with A and B.

One day was allowed to Marconi to prepare these experiments on board the *Vienne*, and they were to have been carried out on the days following, and checked at the different stations—the *Vienne*, Wimereux, and South Foreland. Unfortunately, the young inventor



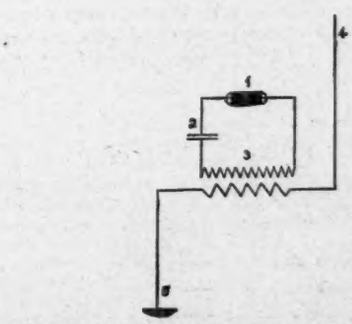
1, Antenna; 2, Oscillator; 3, Battery; 4, Morse key; 5, Earth.

FIG. 21.



1, Battery; 2, One cell; 3, Inductance coils; 4, Hammer; 5, Coherer; 6, Relay; 7, Morse key; 8, Antenna; 9, Earth.

FIG. 22.



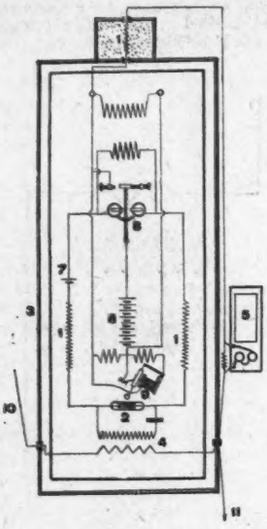
1, Coherer; 2, Condenser; 3, Inductance coils; 4, Antenna; 5, Earth.

FIG. 23.

met with an accident after the preparatory experiments, and the final tests could not be made. Nevertheless, although the results were not checked at the Wimereux and South Foreland stations, the Committee were enabled, during the preparatory trials, to express their opinion in favour of the probability of the above-mentioned claims.

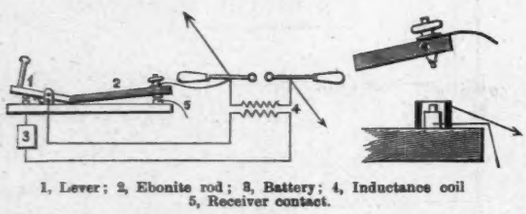
The *Vienne* (31 m.) and the Wimereux (37 m.) stations having been tuned differently, were not able to communicate with one another as long as the distance between them exceeded 2,500 m. But, within that limit, communication was as clear as between two syntonised stations.

The transmitting station used by Marconi in his experiments across the Channel is that shown diagrammatically in fig. 21, and the receiving station is shown in fig. 22. Marconi used his jigger (syntony, fig. 23). The details of the receiver, protections, &c., are shown in fig. 24. Marconi used the Morse key (fig. 25) as a switch for his antennæ. By pressing down the key, communication was interrupted between the antenna and the



1, Inductance coils; 2, Coherer; 3, Metal box; 4, Jigger: 5, Morse key; 6, Battery; 7, One cell; 8, Relay; 9, Hammer; 10, Antenna; 11, Earth.

FIG. 24.



1, Lever; 2, Ebonite rod; 3, Battery; 4, Inductance coil 5, Receiver contact.

FIG. 25.

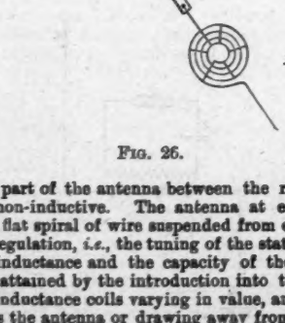


FIG. 26.

receiver. That part of the antenna between the receiver and the Morse key was non-inductive. The antenna at each station was terminated by a flat spiral of wire suspended from ebonite cylinders (fig. 26). The regulation, *i.e.*, the tuning of the station was effected by varying the inductance and the capacity of the antenna. The first object was attained by the introduction into the lower part of the antenna of inductance coils varying in value, and the second by bringing towards the antenna or drawing away from it two pieces of metal network 40 cm. wide, connected to earth. These modes of regulation certainly seem capable of being simplified, and they have been modified since, as we shall see in the experiments between France and Corsica.

In the early part of April, 1901, the International Marconi Co., authorised by the French Government, who sent special delegates (in particular Captain Ferrié), established wireless telegraphic communication between Biot (near Antibès, in France) and Calvi, in Corsica, the distance being 175 km. The antenna at Biot was 52 metres and that at Calvi 55 metres high above the apparatus; they were inclined at about 3 in 1. The two antennæ consisted of four cables connected in parallel (at the extremities) and 1·50 metres apart from one another.

The support of these antennæ consisted of a mast similar to that of a ship, divided into three parts and shrouded at three different heights. The lower shrouds consisted of steel cables and the others of ropes. The shrouds were arranged so that the antenna was as far away as possible.

It is interesting to calculate what was the relative position of the antennæ, taking into account the curvature of the sea and the refraction.

If we draw (fig. 27) at a tangent to the surface of the sea a line A r representing the trajectory of a luminous ray proceeding from the summit A of one of the antennæ in the direction of the other

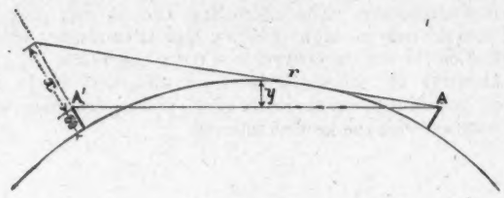


FIG. 27.

antenna, we find, on applying the formula of General Perein, that this line passes at x = about 1,350 metres above the summit of the other antenna A'. In the same way calculation shows that the line joining the point A to the point A' (following the trajectory of a luminous ray in the air) would pass at y = about 500 metres below the level of the sea.

The transmitter (fig. 28) was characterised by the employment of two bobbins having their primaries connected in series and their secondaries in parallel. The rest of the apparatus is known to the

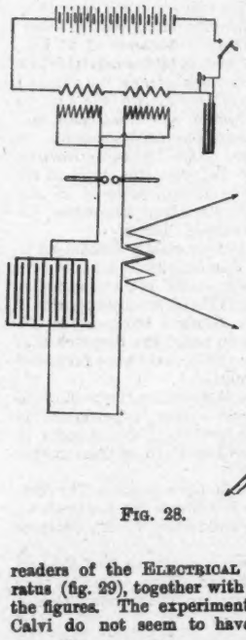


FIG. 28.

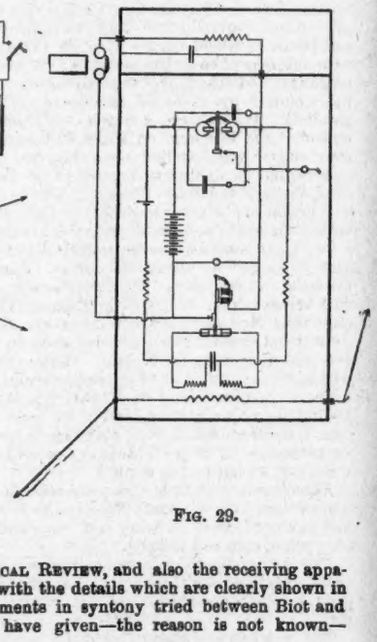


FIG. 29.

readers of the ELECTRICAL REVIEW, and also the receiving apparatus (fig. 29), together with the details which are clearly shown in the figures. The experiments in syntony tried between Biot and Calvi do not seem to have given—the reason is not known—

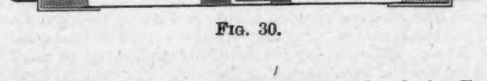


FIG. 30.

absolutely conclusive results. We have mentioned the French naval engineer Ferrié, who was delegated by the French Government to carry out the experiments across the Channel and those between France and Corsica. M. Ferrié, who was appointed to the wireless telegraphy service by the Minister of War, is not by any means unknown in the domain of telegraphy through space. His researches—as shown by his connection with M. Blondel at the Congress of Paris in 1900—in wireless telegraphy are extensive and highly interesting, although most of his experiments are, unfortunately, imperfectly known.

The scheme of connections in military stations used by M. Ferrié includes a potentiometer for regulating the sensibility of the coherer, and the employment of a single source of energy (accumulators). The Ferrié coherer (fig. 30) is of the Blondel type with a reserve chamber. M. Ferrié often suppresses the battery in the relay circuit. The battery is replaced (fig. 31) by two plates of different metals buried in the damp earth. We will only quote the last out of all of M. Ferrié's remarkable experiments. M. Ferrié, with provisional installations, and antennæ of 50 metres supported by lighthouses, has made successful experiments at distances extending to 240 km. at sea, and he thinks much greater distances might be attained.

M. Ferrié has always devoted himself to finding out the truth and working out correct theories and possible applications in wireless telegraphy. He owns that he has not yet succeeded, but he does not despair. M. Ferrié, although very sceptical as to the future of wireless telegraphy, is not sceptical with regard to trans-Atlantic wireless telegraphy.* He believes that it is only a question of

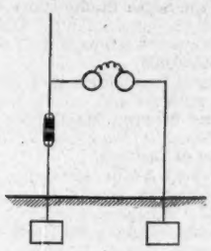


FIG. 31.

cost. He thinks, in fact, that by working simultaneously a large number of antennæ considerable distances may be attained, but that there would be great difficulties in the way of their realisation. M. Ferrié had installed at Dunkirk a provisional station on the occasion of the departure of the French squadron for Russia. There he was enabled to receive telegrams from a number of English Marconi stations—South Foreland, Dover, Beachy Head, &c. This led him to assert that syntony is no protection (or only a very limited protection, we venture to add).

According to M. Ferrié, wireless telegraphy will *never* render multi-communication possible practically, and will never guarantee the secrecy of transmissions from an indirect receiver any more than it will prevent a careless or unskilful operator from disturbing the reception at a station. We may, perhaps, says M. Ferrié, find a means of producing sustained—that is to say, not deadened—oscillations (this seems to have been done, and by Marconi), and we may succeed in realising multi-communication in certain cases, but the receivers will not always be protected against multiple resonance. We will now venture to bring forward certain objections to M. Ferrié's assertions.

We agree with him—except with regard to the means of realisation, at least practically—that trans-Atlantic wireless telegraphy is not a dream, as it has been realised by Marconi. We agree with him that syntony—which allows of radiation at the transmitter, and, moreover, of the collection at the terminals of the coherer of the greater part of the energy—will *never*—and we shall see presently why and how—*realise in a complete and more particularly in an absolutely practical* manner—secrecy and multi-communication, and at the same time avoid the mixing-up of despatches; but is it not hazardous, not to say rash, to say that wireless telegraphy will *never* realise these desiderata? M. Ferrié may know the present, but what does he know of the future? Does he possess the keys of its mysteries?

The writer affirms moreover—and defies anyone to prove the contrary—that with a perfect limitation of the space allowed for the transmission and reception of waves, secrecy is assured, confusion avoided, and multi-communication effected more satisfactorily and more certainly than in ordinary telegraphy. Perhaps this solution is much nearer to its realisation than M. Ferrié thinks.

May the efforts of the pioneers of wireless telegraphy—among whom M. Ferrié may be reckoned as one of the most valiant—soon convert him from his terrible scepticism. I am sure that M. Ferrié will consider it a point of honour to renounce his ideas, if he sees good reason for doing so. We do not blame those who loyally and honestly renounce their ideas if they are false and are shown to be false, but we do blame those who refuse to recognise the evidence and the existence of the brilliant future of wireless telegraphy, and still more those who say the opposite of what they think—those who see in an invention, wireless telegraphy, for instance, an obstacle in the way of their desires and their hopes, which are, alas, too often ill-founded.

WATER-TUBE NAVY BOILERS.

ANOTHER report has been issued by the Boiler Committee dealing with the trials of the gunboats *Sheldrake* and *Seagull*, which are fitted with Babcock & Wilcox and Niclausse boilers respectively, and of the sloops *Espiègle* and *Fantôme* similarly fitted. All are small vessels, the two gunboats being of 735 tons displacement, and the sloops of 1,074 tons and 1,400 H.P. The horse-power of the gunboats is 3,000 each according to the Navy list. Large numbers of tables accompany the report, and in a comparison drawn, it appears that the Babcock boilers responded better than the Niclausse to the demands on them for power probably on the gunboats, because the Babcock boilers had 15 per cent. more heating surface. The trials, it is said, were too short to prove that defects would not appear on actual service, and one is inclined to wonder why the tests were thus made of so little value. The Niclausse boilers are said to have given wetter steam than the Babcock, owing, probably, it would seem, to the comparative smallness of the steam drums, which gave a water surface less than half that of the Babcock drums, and barely above a third ($\frac{1}{19}$) of the steam space.

The Niclausse boilers, however, showed less loss of water than happened with those innumerable invisible leakages which helped to ruin the Belleville boiler. Thus in the coal endurance trial of the *Fantôme* the evaporators were not used, but in the *Espiègle* one evaporator was run for 14 hours on a 90 hours' run. The efficiency of the boilers of the sloops fell off seriously during the coal endurance trials. This is attributed to the necessity for cleaning fires. For eight, or even 16 hours, the *Espiègle* showed 1·88 lb. of coal per H.P.-hour; the *Fantôme* 1·91 lb. per H.P.-hour, as against 1·86 lb. for each ship on the short trials. After 16 hours the efficiency fell off. The gunboats were boilered in 1897, the sloops in 1901, and the newer boilers show better efficiency, as, for example, a maximum 73·2 per cent. in the *Espiègle* against 66 per cent. in the older *Sheldrake*, or an average of 67·8 per cent., against 63·1 per cent. For the Niclausse boiler a maximum of 69·8 per cent. was shown in the *Fantôme* against 66·9 per cent. in the older *Seagull*, and a mean of 63·4 per cent. against a mean of 63·2. The larger tube Babcock of the *Espiègle* showed better efficiency than the small tubes of the *Sheldrake*. This is probably due, it is thought, to the tube variation, seeing that the Niclausse boilers do not show so much difference, and have not different tubes in the old and new boilers.

Feed regulation of all the boilers was easily performed by hand on even the longer trials, but automatic regulation is recommended. This was fitted on the *Fantôme*, and worked without trouble. Those of the *Espiègle* did not work well, but stuck at times, and let down the water level improperly, or allowed it to rise too high.

The Niclausse boilers appear to have been crowded into a space less than the Babcock boilers at some sacrifice of other advantages. In the *Sheldrake*, however, with $1\frac{3}{8}$-in. tubes, the weight is 8 per cent. less than in the *Seagull*, with its 15 per cent. less heating surface, and also six boilers as against the four of the *Sheldrake*, which must imply a greater weight, for in the sloops the Babcock boilers are 25 per cent. heavier than the Niclausse, though the surfaces are very little greater. The tubes, however, are about alike.

It is satisfactory to find that all water-tube boilers are not proving so absolutely unsatisfactory as the Belleville.

BRITISH VIEWS OF AMERICAN WORKSHOPS.

Cassier's Magazine contains a speech by Mr. Alfred Mosley, made in New York, on the questions of piecework and general shop policy.

Mr. Mosley is the man who at his own expense took 23 delegates from British trades to make a tour of the United States.

He credits Americans with the success of South African mining, and he found Americans willing to help his tour of delegates in a way that surprised him, an attitude, by the way, which he does not, however, appear to have thought upon in connection with the U.S. wall of prohibitory tariffs. His tour lasted six weeks, and embraced the manufacturing country as far west as Chicago. He attributes all successful American competition to piecework, better wages, and cheap manufacture; but he overlooks various other matters, and does not appear to know that American stuff over here, when of the best order, does not appear to be in any sense cheaper than the more durable articles of home manufacture. No matter if it be boots, which do not stand our wet conditions, or steam engines, which are painfully short-lived, or locomotives, which Egyptian and other experience condemns, it does not appear that American competition is much to be feared by good firms at home, who still aim at a certain durability. It by no means follows that what suits America will suit other conditions, and we believe that in many directions the touring delegates did not receive the impression that American methods could last successfully. Mr. Mosley may condemn jealous foremen as standing in the way of a good workman's advancement; but there are bad foremen in America, and the more we are able to secure information the less we find are the real differences in the treatment of men on both sides the Ocean. Everthing is much newer over there, and this exercises a certain effect on conditions. It is very doubtful, indeed, if there is so very much in the greater output cry of which we hear so much. Our best shops may be doing as good an output as American shops, but they don't make so much fuss about it.

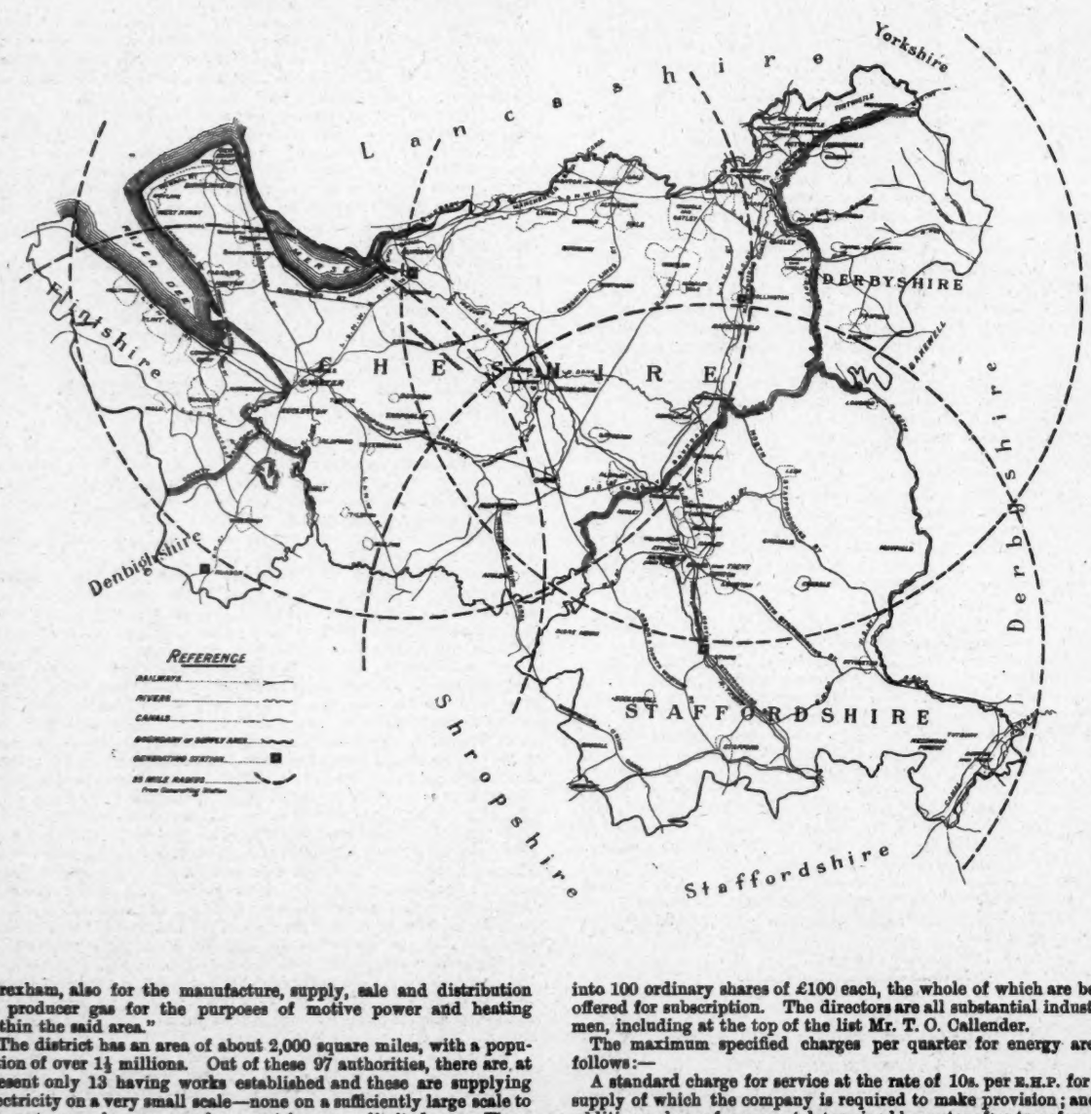
The whole question resolves itself into one of a comparison of conditions, of materials and of the purchasing power of wages. So far the shop hours in America are longer than here, which looks as though under American conditions a man must do more work. How much money do American coal miners earn as compared with men at home? Very much less, we believe. Conditions in the United States—a wide country, vary enormously, and one section presents aspects and conditions very different from those of another. A true balance is impossible, but probably Mr. Mosley's delegates will have brought home much of good that they may make known here, while at the same time avoiding the less admirable lines of policy which govern some American workshops.

Morley.—Plans and specifications are being prepared by the B.E.T. Co. for the construction of tramlines in Morley, with a view to the work being taken in hand during the present year.

* This article was written before the successful trials of Mr. Marconi's trans-Atlantic installation took place.—EDS. ELEC. REV.

THE NORTH-WESTERN ELECTRICITY AND POWER GAS SCHEME.

The accompanying map shows the proposed area of supply under this scheme for which the prospectus of the North-Western Electricity and Power Gas Syndicate, Ltd., is now in circulation. The syndicate has been formed for the purpose of obtaining Parliamentary powers and establishing a company for the supply of electricity in bulk to local authorities and power users "throughout the whole of the county of Chester and that portion of the county of Stafford lying north of the southern boundary lines of the rural districts of Tutbury, Uttoxeter, Stafford, and Gnosall, and inclusive of the said districts, together with that part of the county of Derby which lies to the north-west of the boundary between the unions of Chapel-en-le-Frith and Bakewell, and also that portion of the county of Flint comprising the borough of Flint, the urban districts of Buckley, Connah's Quay, Mold, and Holywell, and the rural districts of Holywell and Hawarden, and that portion of the county of Denbigh comprising the borough and the rural district of Wrexham, also for the manufacture, supply, sale and distribution of producer gas for the purposes of motive power and heating within the said area."



The district has an area of about 2,000 square miles, with a population of over 1½ millions. Out of these 97 authorities, there are at present only 13 having works established and these are supplying electricity on a very small scale—none on a sufficiently large scale to attempt general power supply except in a very limited area. Three places are supplied by companies, of which one, viz., Northwich, is supplied with gas for driving power from the works of Messrs. Brunner, Mond & Co.

The area shown on the map includes a large number of important towns and manufacturing districts. The following have no electric supply available:—Stoke-upon-Trent, Etruria, Cheadle, Uttoxeter, Tunstal, Burslem, Leek, Congleton, Newcastle, Stone, Runcorn, Winsford, Middlewich, Weston Point, New Brighton, Hyde, Denton, Dukinfield, Stalybridge, Macclesfield, Nantwich, Glossop, Buckley, Connah's Quay, Mold, Holywell, Hawarden, &c. Those which have a supply of electrical energy are:—Stafford, Longton, Burton-upon-Trent, Hanley, Chester, Northwich, Wallasey, Birkenhead, Stockport, Ashton-under-Lyne, Crewe, Buxton, Wrexham, Altrincham, Alderley Edge, Hoylake and West Kirby. In addition to the above, there are many intervening industrial urban and rural districts without any supply.

The scheme will be on the same lines generally as the South Wales and other Electric Power Acts. It is not anticipated that the syndicate will have to face any serious or costly opposition in Parliament. The district of this scheme joins up to the districts of the Lancashire Electric Power Act, the Yorkshire Electric Power Act, and the Derby and Notts Electric Power Act, as well as to that of the South Staffordshire Mond Gas (Power and Heating) Act.

The capital of the proposed company is £1,500,000, with power to issue debentures for £500,000.

It is proposed to erect four power stations on sites suitable and convenient both for railways and canals, one near Stone, in the county of Stafford, one between Macclesfield and Bollington, one at Sutton, near Frodsham, in the county of Chester, and one near Ruabon, in the county of Denbigh.

Messrs. Lacey, Clirehugh & Sillar have reported upon the industrial conditions of the area and its possibilities in regard to electric and gas power supply. Mr. Humphrey's report on the scope available for the application of Mond gas in the North-Western district, also appears in the prospectus.

The share capital of the syndicate is only £10,000, and is divided into 100 ordinary shares of £100 each, the whole of which are being offered for subscription. The directors are all substantial industrial men, including at the top of the list Mr. T. O. Callender.

The maximum specified charges per quarter for energy are as follows:—

A standard charge for service at the rate of 10s. per K.H.P. for the supply of which the company is required to make provision; and in addition a charge for current determined by meter after transforming as follows:—For the first 5,000 units consumed in any quarter at the rate of 3d. per unit; for all consumed between 5,000 and 10,000, 2⅝d. per unit; between 10,000 and 20,000, 2½d. per unit; between 20,000 and 50,000, 2d. per unit; between 50,000 and 100,000, 1½d. per unit; between 100,000 and 200,000 in any quarter at the rate of 1d. per unit; amounts over 200,000 units consumed in any quarter, at the rate of ¾d. per unit. Or alternatively,

1. For any quantity not exceeding the equivalent of 100 hours of supply at the maximum power which has been demanded at the rate of 4d. per unit.

2. For any further quantity exceeding the equivalent of 100 and not exceeding 200 hours of supply at such maximum power at the rate of 2d. per unit.

3. For any further supply exceeding the equivalent of 200 hours of supply at such maximum power at the rate of 1d. per unit.

CORRESPONDENCE.

Damages for a Lift Accident.

In your issue of December 26th appears a short paragraph under above heading which is calculated to do us serious injury, and we shall be obliged if you will accord us space in a prominent position for the following correction :—

There was no accident whatever to the lift.

A workman, not in our employment, had been set to do some work in the lift well while the lift was working, and his head was struck by the passing cage.

The person working the lift at the time was not one of our people, and was heard by six witnesses to give the usual warnings.

On a legal technicality, the judge ruled that we were in charge of the lift, and not the person who was working it. The jury found that insufficient warning was given to the man to get clear, and we accordingly have to pay.

The case is just one more illustration of the vagaries of the law, and especially of the Workmen's Compensation Act, which in this case barred the man from claiming against his employer.

A. Smith and Stevens.

Battersea, S.W.,
January 9th, 1903.

Direct Working Telephones.

Direct working telephones are largely used on the Continent, and the demand for them in this country is increasing. The number sold is at least equal to the number of medium distance induction coil telephones. There is every indication of the number being increased largely in the near future, as the advantages peculiar to them become better known. Judging from American technical literature they are practically unknown in the United States of America, or at least the demand for them is extremely small. Generally speaking, the other types of telephones are used to much the same extent in all countries. The writer would be pleased if someone conversant with American telephone practice would state the views of the Americans on the merits and usage of direct working telephones.

Magneto.

Electric Shock Fatalities.

In reading your recent leading article on the above, I am surprised you do not mention the Armorduct single-wire wiring method, somewhat fully described in your issue of April 11th, 1902, by the late Mr. Frederick Bathurst, who clearly showed that safety from fire and to the person, as well as economy in construction and maintenance, were to be obtained in a concentric system consisting of a continuous properly prepared steel or iron sheath with an insulated conductor drawn into it, as such a system, requiring continuity in its sheath to maintain the circuit, becomes a simple and reliable self-testing one.

The present case shows the futility of Fire Office or other rules, unless they are based on a very intimate practical experience of the work, as otherwise they are liable to be accidentally broken without anyone being the wiser until fire, or, as in this instance, death, is the result.

In this connection it is well to point out the advisability of arranging switches in small bath rooms which may be within the reach of bathers, either with double-insulated handles, or preferably with earthed covers. The former is a practice I have found desirable for basement and cellar work, even in the days of 100-volt supply.

It is also surprising that a supply in a neighbourhood as populous as Fulham should be distributed at 200 volts *alternating*, a voltage that may not be in general dangerous, but certainly one that under quite ordinary conditions will pass sufficient current from hand to hand, or hand to foot, to produce muscular fixation with the periodicities ordinarily in vogue.

Justus Eck.

The Sugden Boiler.

Allow me to thank you and also Mr. T. Sugden for the information as regards superheating with the above boiler.

The point I desired to emphasise was that it is sometimes convenient to be able to cut the superheater out of circuit while the boiler is on load. This is easily managed in the Babcock-Wilcox boiler by flooding the superheater, which merely has the effect of adding to the active heating surface. The superheater stop valve may be interlocked with the drain and flooding cock in such a way that neglect to blow off flooding water before putting superheater in circuit is impossible. Incrustation is the only objection to flooding, and this, when we consider how frequently the superheater is blown down, is not a serious one. Ordinary precautions should prevent danger from incomplete drainage and leakage at flooding cock.

Regarding the enlarging of headers, so as *more nearly* to approach the combined area of tubes expanded into each, this could be effected in various ways. In the Stirling boiler each tube forms a complete circuit, if we neglect the cross header, which is more in the nature of a sludge drum.

The headers could be constructed rectangular in shape, with two uptakes each of same diameter as horizontal tubes.

Taking into consideration the extra cost in construction, with probable weakening of headers and interference in rapidity of carrying out repairs, this latter being one of the chief points in favour of the water-tube boiler, the gain, as Mr. Sugden points out, is not sufficient to warrant any further alteration in this respect. I am content *tae let that flee stick tae th' wa'*.

For the purpose of testing the amount of improvement obtained by the alteration in design, the boiler would require to be placed alongside a Babcock-Wilcox boiler of equal capacity, under the same working conditions of fuel, draught and load, and steam calorimeter, temperature and consumption tests made, heating surface being the same for both. This would demonstrate the practical advantages, if any, obtained by the changes.

J. C. Stewart.

Partickhill, *January 12th*, 1903.

Electrolytic Meters.

In your last issue we notice a letter from the Electrical Co., Ltd., in which certain emphatic statements are made regarding the accuracy, price, and durability of motor-meters as compared with electrolytic meters.

Price we will not discuss, and as regards durability, we can only say that Bastian meters are maintained on terms that practically guarantee their "life" for 23 years, and this is as long as we find most engineers care to look ahead.

The Electrical Co., Ltd., may back their opinion as regards the accuracy of motor-meters by choosing 12 of *any type they like*, to be tested in series with 12 Bastian meters, under the following conditions :—

1. The meters to be of either 2½-ampere or 5-ampere capacity.
2. The meters to be calibrated at 200 volts.
3. A total of 200 B. of T. units to be passed through the meters, of which at least 10 units is to be passed at ·05 ampere.
4. The tests to be conducted by Mr. James Swinburne or another unprejudiced expert, and the load to be varied according to his discretion (subject to Condition 3), and up to 50 per cent. overload.
5. The makers of the least accurate instruments to pay all fees connected with the test.

The Bastian Meter Co., Ltd.
Chas. O. Bastian, *Managing Director.*

London,
January 12th, 1903.

[A letter from Messrs. Chamberlain & Hookham which arrived too late for insertion in this column appears in our "Notes."—Eds. Elec. Rev.]

The Bayonet Lampholder.

I notice in your leading article of last Friday with regard to the sad fatalities at the Fulham Baths, that the leakage is now said to have been caused by faults in the lampholders,

and this must again raise the question as to how long engineers are going to tolerate this unsatisfactory appliance in installation work.

The bayonet lampholder, which was originally designed for 50 volts, and found fairly safe for 100 volts, has over and over again proved that it is not suitable for high-voltage work. I often wonder why central station engineers insist upon a separation of 3 in. between the poles of distribution boards and the placing of insulating bridges in ceiling roses and wall plugs, while they overlook the bare ½-in. separation on the cap of the incandescent lamp.

Again, competition has cheapened the lampholder so much that it is fitted with a thin stamped case with loose screw rings, while the interior is often not held in its proper position with regard to the segments on the lamp cap, thereby courting short circuit and bad contact.

To make a safe lampholder for high voltage work does not necessarily mean an increase in the size, but if the contacts are arranged at the sides instead of the top of the cap, the distance between the poles can be much increased, while the body of the cap further serves to isolate them.

Some years ago I patented a lampholder on this principle, but found that I should be considered little less than an anarchist if I attempted to do away with the standard bayonet lampholder, while the lampmakers would not contemplate the making and stocking of a new form of lamp cap.

To those who are accustomed to the sight of fused lampholders and blown fuses resulting from the same, surely this must appeal, and it remains to be seen whether consulting and supply engineers would take advantage of any improvement made in this direction.

H. Bevan Swift.

4, Bloomsbury Street, W.C.

Fires Caused by Electricity.

On p. 46 in the current issue of the Electrical Review, under the heading "Fires Caused by Electricity," you state, in reviewing an article that appeared in the November number of *Insurance Engineering* (N.Y.), that the bad work mentioned above can still be found, notwithstanding electrical trades unions. This implies that there is more than one electrical trades union, which is not so, the one I represent being the only one in the country, and this union has during the past 13 years persistently fought the jerry contractor and the jerry wireman.

We are, and always have been, willing to meet the honest contractors in friendly discussion on the subject, and would welcome any system of registration of the wiremen and other electrical workers which would lead to an improvement of the work, as by so doing we should benefit the trade as a whole and improve the position of the workers, who are now at the mercy of any unscrupulous employer for whom necessity compels them to work.

Only recently we offered to meet the London electrical contractors upon this and other matters, and our offer is still open, and, if accepted, I think will lead to a great improvement and the elimination of the "jerry contractor" and with him the scamped work, which is not only the cause of fires, but also, at times, loss of life.

A. Ewer,
General Secretary, Electrical Trades Union.

London, E.C.,
January 13th, 1903.

Speedy Tramcar Erection.

Your correspondent J. W. Smith in last week's issue asks, "What is the largest number of tramcars completed in a given time?" and goes on to state what the gang he belonged to had done at Bristol, which may be fairly considered good work, and greatly to the credit of the engineer, Mr. Heppell.

I do not intend to question this piece of work, but will ask that with your usual courtesy you allow me to state what I consider to be "one better." At Manchester trucks for 75 cars commenced to arrive on October 1st, and from that date until the back end of November, the gang assembled 50 single trucks, and 50 for 25 double-bogie cars, mounted the motors, gears, painted them, placed them under the bodies, and coupled them up, not with usual sized cables, but 19—16 and 19—18.

Thirty-seven of the bodies arrived without light and bell fittings and earth wires; but the whole 75 were handed over to the Corporation during the last three weeks of November—one week 24, the next 30, and the last week 21—and commenced to earn money on 11 new routes on December 1st, and not one of them has been sent back—nor the contractors fetched back to any one for being improperly put together.

The contractors are the B.T.H. Co., of Rugby, their resident engineer Mr. J. B. Cox, their charge foreman Mr. S. Sullivan, and the gang were 18 men all told, neither of whom know who has written this letter, for I am—

Not One of the Gang.

Manchester,
January 13th, 1903.

Electrical Engineers and Fuel Economy.

The interesting article by Mr. W. H. Booth upon "Flame Analyses and Fuel Combustion," which appeared in your issue of January 2nd, deserves some comment. With Mr. Booth's remarks upon the indifference of the average electrical engineer to the chemistry of fuel combustion I entirely agree. Mr. Booth states that, to his knowledge, "there is not more than one electrical station within six miles of Charing Cross wherein the slightest appreciation of the necessary chemistry of combustion can be found embodied in the steam generating plant."

I can amplify this statement by asserting that I have not been able to find a single generating station in this neighbourhood where regular chemical examination of the fuel and flue gases is practised. In other words, electrical engineers run the most important section of their generating plant entirely by rule-of-thumb methods, and Mr. Booth's reference to the "dark ages" is fully justified.

One cause of this neglect of the science of fuel combustion may be found in the ordinary course of training for electrical engineers, which is directed too exclusively to the electrical engineering side of station management.

A second cause of this neglect may be found in the fact that boilers and stokeholes are dirty and messy in character, and that the engine and dynamo house is a more satisfactory place in which to spend time not devoted to office duties.

The effects of this neglect of the science of fuel combustion may be seen in the striking and wonderful variations in the column devoted to *fuel costs per unit* in the comparative tables which appear weekly in a well-known contemporary. This column is certainly interesting to a chemist, for the difference in fuel costs per ton $^{d}/_{a}$ in bunkers can hardly account for such wide extremes as ·20d. and 2·46d. per unit.

May I suggest that electrical engineers should carefully ponder Mr. Booth's latest article, and should devote some of their spare time during the next 12 months to a study of the chemistry of combustion. In 1903 they might be prepared in some cases to apply their recently acquired knowledge on this subject to the practical problem before them, namely, how to obtain the necessary amount of steam for their engines with a minimum expenditure upon fuel.

If they adopt the suggested course of study and practice, I am inclined to believe that not only would the average of the fuel costs per unit for electrical generating stations in this country be greatly reduced, but that the remarkably wide limits of cost which now characterise the column already referred to would disappear.

John B. C. Kershaw.

Waterloo, Liverpool, *January 12th*, 1903.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Jan. 14th, 1902.		Week ending Jan. 13th, 1903.	
Alexandria	Value £52	Alexandria	Value £23
Auckland	2,988	Auckland	180
Bombay	130	Beira	34
Boulogne	10	Bombay	92
Brisbane. Teleg. cable ..	235,000	Bremen	75
Buenos Ayres. Teleph. cable	900	Buenos Ayres. Teleg. cable ..	550
Calcutta	705	,, Teleg. mat. ..	40
Cape Town	469	Calcutta	599
Christiania. Teleg. wire ..	61	,, Teleg. cable	170
Colombo	157	Canada, via U.S.	19
Durban	90	,, Teleg. cable	52
East London	197	Cape Town	1,293
Fremantle	114	Christiania. Teleg. wire ..	36
Gibraltar. Teleg. mat.	98	Durban	937
Greymouth	907	,, Teleg. mat.	98
Hong Kong	118	Fremantle	544
Lisbon	50	Gibraltar	30
Madras	380	Halifax	11
Melbourne	30	Hamburg	118
,, Teleg. wire	1,980	Liban	29
Otago	130	Madras	28
Perth	415	Melbourne	177
Port Elizabeth	420	Nagasaki. Teleg. mat. ..	1,660
,, Teleg. mat. ..	3,200	New York	85
,, Telephones ..	79	Ostend	70
Port Said	30	Otago	530
Stockholm. Teleg. wire ..	48	Port Elizabeth	1,360
Sydney	40	Rockhampton	46
Tokio	188	Rotterdam	38
Townsville	52	Sekondi	63
Wellington	180	Shanghai	184
Yokohama	854	Sydney	31
		Valparaiso	30
Total ..	£249,446	Total ..	£9,127

Foreign Goods Transhipped.

Calcutta. Elec. goods ..	Value £403	Halifax. Elec. carbons	Value £26
Fremantle. Elec. lghtg. mchnry.	4,396	Singapore. Telephones ..	34
New York. Elec. mat.	160	Sydney. Elec. light apparatus	196
Total	£4,959	Total	£245

Newall's Tube Expander.—Makers of small tube boilers should investigate the merits of Newall's tube expander. The steam and mud drums of many small tube boilers are so small that the working of an ordinary roller expander is very difficult. An ordinary expander absorbs a fair amount of power, and is scarcely fit to be used by a boy in a small drum especially because the work is not easily inspected. Some mud drums must even be made with bolted joints to admit of the tubes being expanded at all.

All these difficulties are swept away at one stroke by the Newall expander, which acts on an entirely novel principle. It consists of a mandrel, formed with a head, which is a close fit in the tube. The shaft of the mandrel is less than the head by the thickness of a collar of ordinary stout sheet lead. This shaft is the piston rod of an hydraulic piston in a cylinder, the head of which abuts upon the end of the tube to be expanded, and a fairly close joint is formed. When placed ready for work, the mandrel is drawn out to its full length and inserted in the tube. A lead collar in two longitudinal halves is clasped round the shank of the mandrel, and also pushed

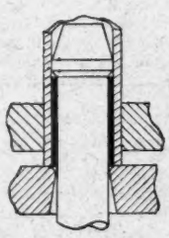


Fig. 1.

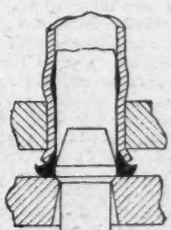


Fig. 3.

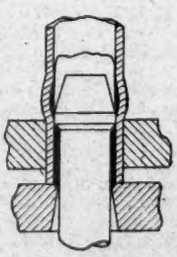


Fig. 2.

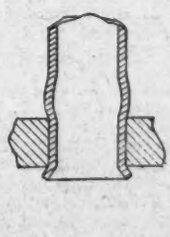


Fig. 4.

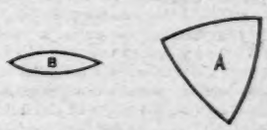
forward into the tube, which it loosely fills (fig. 1). The whole apparatus is then butted against the end of the tube, the operator or his attendant turns on the hydraulic pressure, and the tube is forthwith expanded, and its projecting end splayed over to a bell-mouthed shape.

The action is as follows:—The hydraulic pressure draws the mandrel head forcibly against the lead collar, which is compressed tightly between the mandrel head and the abutting face of the cylinder. Soft lead is not perfectly fluid, and does not transmit pressure like water, nor can it escape through narrow spaces as readily as a more perfect fluid. Hence the greatest pressure of the compressed collar is exerted near the point of application of the load, which is the head of the mandrel. The lead flows under pressure, and expands laterally against the tube, which gives way to the pressure, and is forced hard into the hole in the tube-plate, which it fills perfectly. Where desired, the collar of lead can be kept long enough to expand the tube outside the tube plate, and a swell of any reasonable dimension within the extensibility of the metal can be formed (fig. 2). As the head advances, a thin shell of lead escapes round it, and the collar now begins to exert a great expansive pressure upon the short bit of tube which projects outside the plate (fig. 3). This gives way, and is expanded to an external bellmouth, and finally the lead escapes round the tube end, and the mandrel is released (fig. 4). The whole operation is the work of a fraction of a second.

The lead collars are pressed by a simple press out of a strip of lead sheet, and the cost of lead is merely the difference between the market price of sheet and scrap lead. The correct width of lead strip can be ascertained by experiment on a bit of tube and plate, and, once found for any size of tube, is known for the future. A simple hand pressure pump is used to give the hydraulic pressure in the absence of water pressure laid on. The mandrel head must of course nearly fill the tube, or the lead will escape too readily. The scrap left behind is quite loose in the tube, and is readily pulled out by a hook of wire. This expander can be made for any size of pipe, and is equally applicable to the expansion of pipes plain or screwed into their sockets, to the expansion of the tubes of ordinary water-tube boilers and to the small tubes of boilers like the Weir, Thornycroft or Solignac. It is also specially applicable to surface condensers and to the fire tubes of locomotives or marine boilers. It has the further great advantage that it cannot do bad work. So long as the apparatus is held against the tube end, the work must be done right. If not so held the lead collar will be pushed out, and only a collar will be wasted. The rapidity of the work is many times that of the ordinary expander, and the labour trivial.

The tube ends are left soft after expansion, instead of being made hard and brittle as they are by the roller expander.

Angular Hole-Drilling Attachment.—It is now nearly 20 years since an angular hole-drilling machine was brought out, but this machine did not prove commercially successful, the reason being that the machine was self-contained, and it was necessary to purchase the whole drilling machine in order to secure the angular drilling portion of it. The new arrangement for angular drilling is being shown by Messrs. Curtis, Gardner & Boxwell, Ltd., of 25, College Hill, E.C. Any drilling machine can be utilised for the purpose, the special apparatus being rigidly attached to the lower bearing of the ordinary drilling spindle. The apparatus consists of a frame carrying a guide block. If the drill is for square drilling, the form A in plan is adopted, and for triangular drilling the form B is employed. If a drill of the form A be rotated in a square hole, it will be found that the corners of the drill describe the four sides of a square, while a drill of the form B will rotate within a triangular hole, its corners traversing the three straight



lines of the enclosing boundary. The drill is fitted with a driving dog at its upper end. This is driven by two rollers running on pins attached to a cross-head, which is fixed to the drill socket of the drill spindle. The driving dog is free to move laterally upon the driving rollers. Thus, when the drill spindle is set revolving, the guide plates held in the frame foot constrain the drill to move horizontally to and fro during revolution, and the shape of the drilled hole is produced by the cutting points on the drill, and resembles the shape of the guide. The device is thus really a species of copying machine. The guides in which the drill runs are adjustable, so as to provide for any size and shape of hole. It is greatly to the advantage of this device that the apparatus is applicable to any ordinary drilling machine. The punching of square holes is not an easy operation, while the squaring of a round drilled hole is an operation requiring considerable time. With this machine holes may be made with three, four, five, six, seven, eight, or higher number of sides, so that it is capable of occupying a wide field. A machine fitted with the attachment can be seen at work at 25, College Hill, E.C., and we understand that it is intended to manufacture the apparatus in this country. For all ordinary sizes the whole attachment only weighs a few pounds. It will, of course, be observed that there is no rigid attachment of the drill to the drill spindle. The axis of the drill does not remain in line with the centre of rotation of the drill spindle. Hence the use of the friction rollers on the driving dog. It is important that the curvature of the sides of the drill, as shown in cross-section A and B, should be such that the drill has no shake in its guiding hole. It is on the correct choice of the curvature of the drill checks that good work depends. This form once found, the rest is simple.

What the Consuls Say.—Consul Ronald Macdonald, in his report just published on the trade and commerce of Bilbao (Spain) for the year 1901, states that electricity generated by

water power is beginning to play a very important part in the industrial development of the Basque provinces. Many of the smaller towns and country villages are lighted by electricity so obtained at the extremely moderate charge of 2 pesetas—about 1s. 2d.—per month for one lamp of 10 c.p. per night. Almost all the dynamos and electrical plant used are procured from Germany. Several companies were formed in 1901 for the supply of electrical power, the two most important being the "Sociedad Hidro-Electrica Iberica," which has a capital of 20,000,000 pesetas—£600,000—and has secured water rights in various provinces throughout Spain. This society proposes to furnish power to Bilbao, Santander, Barcelona, Valencia and Alicante. It has begun work on the Ebro River, and expects to be in a position to supply 6,950 h.p. to Bilbao early this year (1903). This force is to be employed in various industries such as corn and paper mills, tramways, tin-plate works, &c. The other company is called "Sociedad del Salto del Ter," and has bought water rights for a sum of £30,000, with a view to furnishing power to Gerona and Barcelona. The town of Bilbao is now lighted by steam-generated electricity, the mean rate charged being 3 pesetas 50 c. (2s.) per month per lamp of 10 c.p. per night. The firm of J. Ahlmeyer & Co., which has been established in these provinces for some years, has amalgamated with the Hispania Co. and bought the business of the "Sociedad Bilbaina de Electricidad." The capital of the new company amounts to 30,000,000 pesetas (£900,000). Apart from its local business it has secured important orders, such as the lighting of Cartagena and supply of electrical power in the neighbourhood of that town. Vice-consul Major Nutt (San Sebastian) reports that an electric tramway has been constructed between Ategorrieta and the top of Mount Ulca, where a handsome restaurant has been built. It will be open to the public in the spring or early summer, and is expected to prove a most popular excursion. The distance is about two miles. Another line is in course of construction to Hernani (5½ miles), and will be finished in the course of the summer. A concession has also been granted for a line to Tolosa, passing through Oria, where the large and flourishing cotton factory of Messrs. Brunet is situated. Major Nutt also reports that there are now some 50 or 60 hydro-electric industries working with water-power, and additional concessions have been asked for. The electric lighting, the water supply, and the sanitary conditions of San Sebastian, he states, are excellent. Vice-consul Shade (Castro-Urdiales) reports that both the town of Castro and the villages of the municipal district are lighted by electricity, the cost of which is 3 pesetas (or at present exchange 1s. 10d.) per lamp of 10-c.p. per month.

Workmen's Compensation.—At St. Helens County Court last week, before his Honour Judge Shand, a case which had been remitted from the High Court, was heard, in which a young man named Enoch Williams sued the British Insulated Wire Co., Ltd., Prescot, for injuries sustained, and claimed £250 compensation. Mr. Byrne (Manchester) stated that the plaintiff had come to Prescot in 1901, and being out of work, had gone to the wire factory and was offered work at 18s. a week. He was put to work at a machine which rolled wire. He had to guide the wire in the machine, and when doing so, slipped, and his right hand was badly lacerated and injured. For this he claimed compensation. The machine was not securely fenced as required by law, and to put an inexperienced man to attend to such a machine was highly dangerous. Since the accident the machine had been fenced. For the defendants, it was contended that plaintiff had agreed to accept compensation under the Workmen's Compensation Act. The Judge said that from the evidence, the plaintiff did not seem to understand that, and had not entered into an agreement. An award of £100 as compensation, and costs, was made.

Leicester Tramways.—As mentioned in "Contracts Closed" last week, Messrs. Robert W. Blackwell & Co., Ltd., of London, have secured the contract for the overhead equipment of the Corporation tramways, comprising about 14 miles of route. It is interesting to note that whereas a few years ago a very large proportion of the material used in the construction of trolley lines came from abroad, in Leicester at least 99 per cent. of the material will be of British manufacture.

Press Directory.—*Willing's* very useful "Press Guide" for 1903 has come to hand for review as usual. There is little to be said beyond the opinion expressed by us in previous years. It is a very serviceable publication and is good in its arrangement. It has reached its thirtieth annual issue. (125, Strand, W.C. 1s.)

St. Louis Exposition.—We have just received from Mr. W. E. Goldsborough, chief of the electricity department of this great exposition, which is to open in April next year, a copy of the revised edition of circular No. 1, in which details are given respecting the grouping and classification of the electrical engineering exhibits. All who take any real interest in the St. Louis show should obtain a copy of this circular.

Colliery Electrical Plant.—Messrs. Bolckow, Vaughan and Co. are said to have commenced the putting down of electric plant for the working of the machinery at their Westerton and Binchester Collieries. Electric plant is also being installed for the working of the underground machinery at the Byers Green Colliery.

At Last!—Electric fans are said to have been fitted on the Court floor at the Law Courts so as to better ventilate the corridors.

Motor-Cars on Hire.—We have received a small pamphlet containing "Some Words About Motor Hiring" and the commercial use of motors, from the Motor Hiring Syndicate, of Winchester House, E.C. Our first assumption when the title caught our eye, was that it was a disquisition upon some new system of hiring out electric motors, and that it was intended to make it easy for the steam-power user to end his waste and adopt electricity with a minimum initial outlay. A glance inside, however, revealed the fact that it has reference to a system of hiring out motor-cars, or automobiles, or what you will, for the transport of heavy loads. The company has 50 such vehicles on hire, and it "takes all risks, supplying driver, fuel, lubrication and repairs" at a weekly rental, whose amount is not stated. Manufacturers and contractors who do not feel inclined to spend outright a comparatively large sum of money upon a steam lorry, or so forth, might find it useful to study one of these little circulars.

Electricity in Hospitals.—On Friday last the Duke of Northumberland opened the Home Hospital, Fitzroy Square, which is noteworthy because of its very up-to-date electrical details. It has been provided with a special service throughout, with connection in each room and on each landing for sterilising, heating, cooking, steaming, ventilating, &c., or for the working of Finsen and Röntgen rays apparatus. Also, in the Operating Theatre the electrical contractors for the entire work, Messrs. Duncan, Watson and Co., have provided one of the latest cautery appliances, which allows the current to be taken direct from the main at 220 volts and changed by a vibrator into alternating current and transformed into the required heavy current for the purpose of cauterising tools. We are informed that this is the first time that one of these instruments has been applied to hospital work. All the rooms have been fitted with electric light, and there is a switch by the side of each patient's bed, also a wall-plug for either a surgical lamp or reading lamp. Food trolleys have been designed for conveying food from the kitchen to the various floors in a food lift. These are made of teak, lined with a non-conducting material known as Cabot's sheathing, which is American eel glass within a casing of asbestos. Inside the Cabot's sheathing are sheets of uralite. Each trolley contains shelves made of perforated aluminium, on which the dinners for the various rooms are placed, and the whole is heated inside by means of an electric plate at the bottom. The electric plate will be charged in the basement, and will remain hot for about an hour. The passenger lift, which travels from the basement to the fourth floor, and is worked by an electric motor, is of sufficient size to take a patient in an ambulance, a nurse, doctor and porter, and the time occupied by the whole journey from ground floor to operating room is less than a minute. The work includes inter-communication telephones, electrical signals on each floor, the connecting of the electrical lift, &c. The power circuit is supplied by the borough of St. Pancras at a charge of 2d. per unit.

Dissolutions and Liquidations.—Creditors of the Buenos Ayres Electric Tramways Co. should send details of their accounts, &c., to the liquidator, Mr. E. G. Summers, St. George's House, Eastcheap, E.C., by February 28th.

Mr. Justice Buckley, sitting in the Chancery Division on Tuesday for the disposal of company business, had before him a petition by E. N. B. Donisthorpe and another for the winding-up of Electromotion Corporation, Ltd. Mr. T. F. Hart appeared for the petitioners, and stated that it was a creditor's application. Arrangements had been made by which the case had stood over from time to time. He understood that an agreement had been come to between the petitioners and the company, the petitioners including all the creditors. One of the terms of the arrangement was that the petitioners should have their petition dismissed without costs. His Lordship consented.

First meetings and public examination in *re* A. E. Pemberton, electrical engineer and contractor, of Sale, are to be held on January 16th and February 9th respectively, both at Manchester.

First meetings and public examination in *re* John F. Worthington and G. Nuttall (J. Worthington & Co, electrical engineers, Foundry Works, Hanley, Staffs.) will take place on January 16th and 28th respectively, the former at Stoke-upon-Trent and the latter at Hanley.

Messrs. A. H. M. Francis and R. S. J. Spilsbury (Francis and Spilsbury, electrical engineers, 20, Bucklersbury, E.C.) have dissolved partnership. Mr. Francis attends to debts, and will continue the business.

A petition for winding up the Electric Lighting Boards, Ltd., has been presented by Mr. O. T. Banks, and will be heard on January 20th. On 29th ult. the company passed resolutions winding up voluntarily, and appointing Mr. W. H. Pannell, of 13 and 14, Basinghall Street, E.C., liquidator.

Mr. David Urquhart having retired from the business of Messrs. Urquhart & Small, consulting engineers, 17, Victoria Street, S.W., Mr. J. Miln Small has become sole and responsible representative, and in future he will carry on the business under his own name.

Willans Engines.—The Oudh and Rohilkund (India) Railway has decided to instal a Willans compound engine for direct coupling to a Crompton dynamo. The proprietors of the Auckland Park Colliery are about to instal three 360-h.p. Willans engines for direct coupling to multiphase generators of the A.E.G. make. These generators are to be used for supplying power to their colliery.

For Sale.—The Bethnal Green Board of Guardians want tenders for the purchase of a battery of E.P.S. accumulators, with connections, &c., complete.

Trade Announcements.—Mr. Arthur Koppel, of 27, Clements' Lane, E.C., has taken up the agency for London and the home counties for the sale of locomotive steam cranes manufactured by Messrs. B. Johnson & Son, of Bramley, near Leeds. He has issued a new list of improved steel crane skips of which he keeps a stock in London.

The business hitherto carried on by Mr. Thomas Smith at the Steam and Electric Crane Works, Rodley, near Leeds, will in future be carried on as Thomas Smith & Sons, he having taken his sons into the business. The works have been recently transformed, new and improved machinery having been introduced into every department for the economical and efficient manufacture of every type of electrical, steam and other cranes, and every description of lifting machinery. A new installation of plant for electrical driving has been laid down, it including a Belliss & Morcom high-speed engine.

As announced in our "New Companies Registered" column the week before last, a company has been registered with the title Wm. Augs Gibson, Ltd., for the manufacture and sale of lifts. This company has been organised by Mr. Gibson, a former president of the American Elevator Co., and later the managing director of the Otis Elevator Co., Ltd., which was recently amalgamated with Waygoods. The offices of the new company will be situated at 28, Fleet Street, E.C., and it will deal in electric, hydraulic and hand-power lifts made in this country.

The Armorduct Improved Electric Conduit Co., which was carried on by the late Mr. Fred. Bathurst, has been purchased by Mr. W. Schmahl, of the firm of Atkinson, Schmahl & Co., of Newcastle. The administrative offices of the company have therefore been transferred to 5, St. Nicholas Buildings, Newcastle-on-Tyne, and the London offices and stores have been removed to 6, Broadway, E.C. Mr. Schmahl will collect outstanding accounts, and takes over responsibility for all orders placed by Mr. Hervey Bathurst on behalf of the company up to December 1st, 1902.

Messrs. W. F. Dennis & Co. are removing on 15th inst. to larger and more convenient offices at Albert Buildings, 49, Queen Victoria Street, E.C.

Calendars and Catalogues.—A serviceable calendar well suited for the walls of large offices because of its bold figuring, has been received from the GLACIER ANTI-FRICTION METAL CO., LTD., of Queen Victoria Street, E.C.

The HART ACCUMULATOR CO., LTD., of Stratford, has brought out a new illustrated price list in which are set out in an exceedingly neat and clear style the various details, dimensions and prices of their lighting, traction, central station, portable and ignition batteries, also sundries for use in connection therewith. The particulars have been brought up to date, and several new types of cells are included.

A wall calendar with monthly slips for 1903 has been sent to us by Mr. G. BRAULIK, of Upper Thames Street, E.C.

Mr. S. H. HEYWOOD, of Reddish, has placed before us copies of sections 2 and 3 of his catalogue containing descriptions of his motor-starting switches and crane controllers which are being manufactured in large quantities in convenient sizes, and are being largely supplied to railway and industrial companies, &c. Both lists are very neatly arranged and nicely illustrated, and have prices set out in table form at the end. No. 2 is devoted to starting switches and resistances for continuous currents, and No. 3 to starting and reversing controllers and resistances for ditto.

A small circular has reached us from the C. W. HUNT Co., of America, giving some views and particulars of their narrow and broad gauge electric storage battery locomotives.

MESSRS. D. ANDERSON & SON, LTD., of Lagan Felt Works, Belfast, have sent us one of their illustrated roof booklets, showing views of some of the roofs erected by them in the United Kingdom during the past few years. The principle adopted is the "Belfast" roof, consisting of wooden lattice girder principals covered with sheeting and felt. They can be built in spans up to 100 ft., and are very light and durable. Among others for whom Messrs. Anderson have done work of this kind we note the names of the General Electric Co., Ltd., the Castner-Kellner Alkali Co., the British Power, Traction and Lighting Co., Ltd., and Willans & Robinson.

MESSRS. MATHER & PLATT, LTD., have published a new catalogue, in which they describe in some detail and by the aid of diagrammatic and other illustrations, the Körting double-acting two-cycle gas engine, which it is now pretty well known they are manufacturing in this country.

Several new illustrated lists have been issued by MESSRS. THOMAS SMITH & SONS, of Rodley, Leeds. No. 45 is devoted to locomotive steam cranes, No. 46 to locomotive electric ditto, and No. 47 to three-motor type electric overhead travellers.

MESSRS. ERNEST SCOTT & MOUNTAIN, LTD., have sent us one of their pamphlets (No. 43), giving a full illustrated description of an electrical transmission plant which was recently constructed by them for the Port Talbot Iron and Steel Co., Ltd., of South Wales. The plant comprises a 150-KW. continuous-current generating set, several three-motor cranes of different capacities, motors in sizes varying from 80 to 3 H.P. for driving hot and cold saws, blowers, straightening machines, screw down gear, scull breaking winches, dolomite mill, &c.

The BULLOCK ELECTRIC MANUFACTURING CO., of Cincinnati, have sent us a set of their artistic monthly calendar cards. Each has a photographic reproduction of a scientific celebrity, including Bunsen, Darwin, Hertz, Huxley, Lister, Tyndall, Joule. For the merry month of May the company has selected as worthy of being coupled with these world-renowned "Great Men of Science and Engineering" its own engineer, B. A. Behrend. The number of this card, be it mentioned, is 17. Some notes of the career of each of the thus honoured scientists is given on the back of their cards. As monthly reference calendars the cards will be very handy.

MESSRS. BUCK & HICKMAN have sent us a card of the Pratt and Whitney Standard hand reamers.

MESSRS. F. C. MATHIESON & SONS, of Copthall Avenue, have issued the thirty-first yearly edition of their "Highest and Lowest Prices," showing the fluctuations and course of business in all officially-quoted securities during the year 1902 arranged in the usual way, and the dividends paid by each for the past six years are recorded.

The WILLESDEN PAPER AND CANVAS CO., LTD., of Willesden Junction, has sent us a wall calendar with daily tear-off slips; also some lists of its roofing and insulation papers.

MESSRS. STEVENS & BARKER, of Victoria Works, Maidstone, have issued a price list of the S. & B. standard enclosed direct-current motors from 1 to 30 B.H.P., giving specification and prices.

A new list (48 pp.) of electro-medical appliances has been brought out by MESSRS. ISENTHAL & Co., of Mortimer Street, W. It is very fully illustrated, and includes more particularly details of instruments dealing with X-rays, high frequency and high potential treatment. The Nodon patent electric valve, for which they are the sole selling agents in the United Kingdom, is explained and shown, and various coils for wireless telegraphy and medical work. All connected with the practice of electro-therapeutics will find the list interesting, and it will be especially of use to merchants and contractors, in whose hands it largely rests to bring such appliances as are here shown to the notice of the right men.

The ELECTRICAL POWER STORAGE CO. is issuing a new edition of its catalogue to the trade. It is an excellent list of these well known batteries, and has a thumb index to the numerous sections which must greatly facilitate reference to the particular class of cell that one is seeking. Working instructions, diagrams, tabulated capacities, weights and prices, and general views of different types of cells for lighting, traction, ship-lighting, electric cab and other purposes are given, also some accessories requisite in connection with accumulator work. The "O.K." cell shown is a new type giving approximately double the discharge rate and capacity, while occupying the same floor space as the "P" type. The "Carsonade" battery is made with a new type of negative, and is specially designed for low maintenance rates. The ship-lighting "W.T." type which the company has been gradually improving during the past two years, embodies many important improvements. We note that the E.P.S. Co. claims that the output obtained from its latest traction cells now reaches 6 ampere-hours per lb. of complete cell when discharged in 5 hours.

MESSRS. R. W. BLACKWELL & Co., LTD., have sent us an excellent pocket note-book, such as engineers who require squared paper for rough drawings will find very handy.

Belliss Engines.—The contract for a steam-driven set for the North-Eastern Railway is in the hands of Messrs. Wilson, Hartnell & Co., who have ordered the engine from Messrs. Belliss and Morcom, Ltd. The Brush Electrical Engineering Co. are supplying a set for Devonport, Tasmania, and the engine is also to be a Belliss. The Bournemouth and Poole Electricity Supply Co. have placed with Messrs. Belliss a contract for one engine coupled to a Brush dynamo.

Electrically-Worked Canal Lift.—The swing bridges over the River Weaver at Northwich have for some time been worked electrically by means of plant supplied by Messrs. Mather and Platt, Ltd., and the Weaver navigation authorities have entrusted to the same firm the work of equipping the Anderton lift, where the Shropshire Union Canal joins the Weaver, with electrical plant. By this conversion, one man in the switch house will be able to control all the necessary movements, whereas hitherto eight men have been necessary to work the lifts. The electrical plant to be supplied comprises two motors for working directly the lock gates at the end of the Shropshire Union Canal, which is 70 ft. above the level of the Weaver, one motor on each of the pontoons controlling by means of ropes the lock gates at either end, and one motor in the engine house directly connected to a variable stroke pump to supply water under a pressure of 700 lbs. per sq. in. to the rams. The two vertical cylinders of the hydraulic lifts are connected, so that as one pontoon sinks it forces up the other. An additional supply of water under pressure is, however, necessary to overcome friction and any difference in weight between the two pontoons.

Books Received.—"Secondary Batteries: their Theory, Construction, and Use," by E. J. Wade. London: The *Electrician* Printing and Publishing Co., Ltd. 10s. 6d.

"Willing's Press Guide for 1903." London: James Willing, jun., Ltd. 1s.

"Transactions of the Institute of Marine Engineers," Vol. xiv. Session 1902-03. London: At the Institute.

"Electric Traction on Street Tramways," by C. Biggs. London: S. Edgecumbe Rogers. 6d.

"How to Work Arithmetic," I. and II., by L. Norman. Rugby: G. E. Over, The Rugby Press. 1902. 1s. 6d. net each.

Electrically-Worked Bridge.—The new bridge being erected at Barking by Messrs. A. Fasey & Sons for the U.D.C. of Barking Town, is of a novel description, being of the roller bascule type. It is to be worked electrically, and the electrical equipment has been entrusted to Messrs. Mather & Platt, Ltd. This comprises two motors of 50 H.P. each, either of which is sufficiently powerful to roll the bridge open, and a controlling switch of special design, by which all the movements are controlled through one lever

actuating a barrel contact. The actual power required, as is seen, is not great, since the cables attached to the rolling portion of the bridge, after passing round the hoisting drums, are attached to heavy counterweights which slide down a specially curved path.

Automobile Exhibition.—An Automobile Exhibition, the eighth of Messrs. Cordingley's series, will be held as usual at the Royal Agricultural Hall, Islington, from March 21st to 28th, and we understand that, although there is yet more than two months before the opening, the whole of the ground floor, minor hall, arcade, several annexes, and most of the gallery has been already allotted.

ELECTRIC LIGHT AND POWER NOTES.

Aberystwith.—The works here are to be opened on the 29th inst. A trial working of two engines at the local generating station has proved highly satisfactory.

Ashton-under-Lyne.—The L.G.B. has sanctioned the raising of a loan of £30,000 by the T.C. for extending the electricity works and plant.

Bath.—Mr. Manville has reported to the T.C. on the extensions to the electricity works, and recommends the substitution of the low pressure direct current system for the present system in the centre of the city. The alternating current machinery will be available for the supply of the more remote districts. Two new D.C. sets, of 500 and 200 KW., are recommended, the latter consisting of a steam balancer. The existing buildings are condemned, as peculiarly liable to fire, and new erections advised.

Bexhill-on-Sea.—It was reported at the meeting of the T.C. on Monday that after considering the tenders received for alterations at the E.L. Works, it had been decided to advertise for fresh tenders.

Brentwood.—With a view to the formation of a larger district for the supply of electricity, the U.D.C. has arranged a conference with parishes surrounding the town.

Brighton.—The Lighting Committee has recommended the T.C. to increase the standard pressure in certain of the E.L. mains from 115 volts to 230, to seek consent from the B. of T. to the change, and to apply to the L.G.B. for a loan of £1,500, the estimated cost of changing the voltage.

Carlisle.—The terms of the T.C. for supplying electricity for lighting the goods yard have been accepted by the Caledonian Railway Co.

Carnarvon.—An electric company has made overtures to take over the Corporation electric lighting order and run an electric supply within the limits of the compulsory area. The matter has been deferred for a report as to the Corporation's power to treat.

Crewe.—The T.C. has decided to light certain streets with 32-C.P. electric lamps.

Derby.—The L.G.B. has granted the application of the T.C. for a loan of £35,000 for the extension of the electric lighting system of the city.

Eccles.—A report on the working loss in connection with the Corporation electricity supply department shows that the loss on the last three months' working was put down at £215 0s. 8d., and for the half year at £618 4s., against £870 16s. in the corresponding period of the previous year.

The T.C. has agreed to contribute to the cost of the appeal to the House of Lords by Eastbourne T.C. respecting the charging of stamp duty upon the purchase of loose articles and materials.

Felixstowe.—The electric lighting company has practically assented to the retention of £3,000 of the purchase money (£8,000) by the Council as security until the latter is satisfied that the E.L. undertaking is a success. In fact, the company has agreed that the £3,000 shall not become due until the profits of the undertaking at the end of any year show 6 per cent. net on the capital expenditure at the commencement of such year. The agreement is to be submitted to counsel to settle on the Council's behalf.

Fife.—The Cupar District Committee has resolved to ask the Fifeshire County Council to oppose the Fife Electric Power Order, with a view of having additional protective measures added, and St. Andrews District Committee has resolved to petition against the prov. order.

Frome.—The U.D.C. has accepted the tender of Edmundson's Electricity Corporation, at £20,156, for the construction of electricity works in the town, the contractors to run the works for 25 years. The only other tender was that of the General Electric Lighting Co, at £20,856.

Gillingham.—The U.D.C. (Chatham) having purchased the New Brompton undertaking of the Chatham and District Electric Lighting Co., has decided to approve of the electrical engineer's (Mr. Trentham's) plans for the extension of the works, and to advertise for a clerk of works to superintend the erection of new buildings, &c. The Council purchased the undertaking for £26,659, and, with other amounts, the total has been brought up to £28,626. Mr. A. D. Chalmers, the resident engineer of the company, will continue his services to the Council for the present, with his working staff, at the same rates of salaries. The Council has resolved to approach the Admiralty with an offer to supply electrical energy for the new Naval Barracks and the Naval Hospital, and other Government buildings and works in the district.

Guildford.—On Monday last, about 7.45 p.m., all the lights in the town supplied by the Guildford Electricity Supply Co. went out. It is stated that owing to the recent heavy rains one of the cables in the upper part of High Street, for a length of about 20 ft., became faulty. This necessitated shutting down for repairs, but the supply was again available about four hours later. The company are taking special precautions to prevent the recurrence of a similar failure.

Halifax.—The T.C. has received a letter from the L.G.B. sanctioning the borrowing of £28,000 for the purposes of electric lighting.

The T.C. has decided that in cases where a consumer of electricity having his own plant demands a stand-by supply from the Corporation, the charge for such supply shall be £4 per annum per kilowatt demanded, and in addition 3d. per unit consumed.

Holland.—The Dutch railway authorities are about to put down a complete electricity generating and lighting plant at the railway station at the Hook of Holland.

Horbury.—The U.D.C. has decided to apply to the B. of T. for an E.L. order.

Liverpool.—Councillor Richard Dart has been appointed chairman, and Councillor W. W. Walker deputy chairman, of the Liverpool Electric Power and Lighting Committee for the ensuing year.

London.—CITY.—An accident occurred on Monday last, about 8.30 a.m., in connection with the cables belonging to the City of London Electric Lighting Co., at the corner of Bennet's Hill and Upper Thames Street. One of the cables, which had been in use for several years, suddenly failed, and was burnt out. The chief engineer, Mr. Bailey, was quickly on the spot, and, under his direction, arrangements were made by which the supply of current was resumed in the area affected within less than two hours.

STEPNEY.—At the Borough Council meeting on Wednesday last week estimates were passed for the laying of a distributing main, an arc main, and one spare duct for the lighting of Upper East Smithfield, and for 13 arc lamps for street lighting.

SOUTH LONDON.—The Blackheath and Greenwich District Electric Light Co. has entered into a provisional agreement to acquire from the Lewisham and District Electric Supply Co., Ltd., the powers that were granted to that company in 1901 to supply electricity in certain defined areas in Lewisham, Greenwich, Camberwell, Penge and Beckenham.

Long Eaton.—On January 8th the E.L. installation laid down by the U.D.C. was inaugurated.

Maidstone.—The T.C. has decided to supply electricity for motive power to the Tovil Paper Mills, the consumer undertaking to pay 20 per cent. of the cost of extending the cables and to take at least £140 worth of energy per annum for seven years.

Manchester.—The Electricity Committee of the Corporation hopes shortly to be able to reduce the price of electrical energy for motive purposes from 1¾d. to 1½d. per unit. The chairman of the Committee (Mr. Howarth), on Wednesday last week, stated that at the next meeting he hoped to be able to lay before the members the result of the inquiries by a special sub-committee into the financial position of the electricity department, and the outlay on the various works.

It appears that the scheme for hiring out motors, although disapproved by the Council under the old administration, has not been abandoned. The late chairman of the Committee, some months ago, asked the Council to sanction a loan of £10,000 for this purpose, but it was refused. The application is to be renewed in the near future, and if it can be shown that the scheme, besides being a desirable thing for small manufacturers, will be financially profitable, the former objections will be removed.

Some time ago Dr. Kennedy was asked to report on certain matters connected with the new Stuart Street station. Dr. Kennedy, however, has written expressing regret that he is "unable to undertake to report upon the demand for current and plant available in the three generating stations." The Stuart Street station was established especially in view of the needs of the city with regard to electric traction. After the work was started, according to the official explanation, it was found that four roads had not been included in the estimate, and a further extension was recommended and adopted by the Committee. By some oversight this was omitted from the reference to Dr. Kennedy, and when asked later to report upon it he declined, on the ground that he might be placed in an invidious position if he took the responsibility of "reporting upon the report of the chief electrical engineer."

Mexico.—The Mexican Government has granted a concession to M. Oscar Braniff to put down plant to utilise the water power of the River Atoyac in the Canton of Cordoba (Vera Cruz State) in the generation of electrical energy.

Newburn.—The Newcastle-on-Tyne and District Electric Lighting Co. has intimated to the U.D.C. that it is now prepared to carry out its agreement with the Council for lighting the town by electricity. The surveyor has been instructed to prepare a special report as to the cost, &c.

Newport.—On the recommendation of Mr. Parshall, consulting engineer to the Corporation, a testing tank is to be provided for the engines and generators at the new works, consisting of an arrangement of resistance coils immersed in water.

Oban.—On Thursday the 8th inst., the electric light installation at Oban—the Charing Cross of the Scottish Highlands—was inaugurated. The generating station, which is capable of extension as the requirements may warrant, has a capacity for 31 arc lamps, and 4,000 incandescent lamps. The arc lamps are used in the lighting of the streets, and of the incandescent lamps already 2,000 have been applied for. The charge to the public is 6d. per unit, and with the price of gas in Oban at 7s. 6d. per 1,000 cb. ft., the new system of lighting should immediately become very popular.

Pemberton.—The U.D.C. has fixed the charge for electricity supplied by meter at 3d. per unit.

Peterborough. — Electric street lighting is being adopted at Peterborough by the Town Council. Prior to this they were customers of the local gas company for public lighting.

Pontypridd.—The South Wales Electric Power Distribution Co. purposes taking possession of certain lands at Llantart Vardie and Treforest, and as arbitration proceedings will be necessary, it has been resolved by the District Council to appoint Mr. Ware, of Cardiff, as valuer.

Runcorn.—The B. of T. has informed the U.D.C. that it has decided to defer revoking the E.L. Order until June 20th next. If by that date the undertakers have not taken definite steps to carry out their obligations under the order, the Board will not be disposed to allow the order to remain any longer in force.

The Council has received a letter from the North-Western Electricity and Power Gas Co., in which the hope was expressed that the Council would see its way to pass a resolution supporting the company's Bill. The matter was referred to the Highways Committee.

Russia.—An electricity generating plant has just been put down at the works at Kamenskoi, Donetz, of the Société Metallurgique Dnieprovienne du Midi de la Russie, one of the largest iron and steel concerns in Central Russia. The plant is driven by gas engines, to operate which the waste gases of the blast furnaces are utilised.

Sleaford.—The U.D.C. has increased the salary of the electrical engineer from 35s. per week to £104 per annum, and has informed him that the Council will make it to his advantage to forward the undertaking by obtaining additional consumers and lessening, where possible, the expenses. We should think so, too!

Sowerby Bridge.—The U.D.C. has asked the South Yorkshire Electrical Supply Co. upon what terms they would supply electricity to the Council, the minimum amount the Council would be required to take, and how soon the company would be in a position to supply at the proposed sub-station near the gasworks. Another company has also been asked for terms, but the Council is considering the advisability of generating electricity itself.

Spain.—A company has just been formed in Bilbao, to be known as the Sociedad Hidro-Electrica de Cataluna, to establish and work a large water-power-driven electricity generating station in Catalonia.

Stroud.—The U.D.C. on January 7th decided to apply for a prov. order empowering the Council to supply electricity within the district.

Sunderland.—At a meeting of the Electricity and Lighting Committee on the 7th inst., Mr. Snell, the borough electrical engineer, submitted a report on the offer of the Durham County Electrical Distribution Co. to supply energy to the Corporation, and it was decided not to entertain the proposal. The tender of the Allgemeine Electricitäts Gesellschaft, of Berlin, for the supply of a three-phase alternator and a Belliss & Morcom engine was accepted at £17,785; the next lowest tender was that of the International Electric Company for £19,135, and the lowest English tender was that of the British Westinghouse Co. at £19,670. Much regret was expressed by the members of the Committee that the order had to be given to a foreign firm, but in face of the very serious discrepancy in the prices they felt they had no alternative.

Surbiton.—The contractors for the new electric lighting station have commenced operations. It is stated that the site is found to be water-logged, and as a result the foundations of the building will have to be set several feet deeper than was originally intended.

Sutton Coldfield.—The T.C. has fixed the price of electricity to consumers on the maximum demand system at 7d. and 3d. per unit.

Swindon.—The T.C. has decided that the charges for electricity for power purposes shall be at the rate of 2½d. per unit provided the consumption exceeds 10,000 units per annum, and 2d. where it exceeds 15,000 units.

In order to encourage the occupiers of small tenements to use electricity for lighting purposes, the T.C. has decided to charge cottagers an inclusive rate of 1s. 2d. per week during the two winter quarters, and 7d. per week in the two other quarters, this to be tried as an experiment for 12 months.

Wallasey.—The L.G.B. has sanctioned the borrowing by the U.D.C. of the sum of £31,350 for extensions of the electrical generating station and plant for lighting and traction. The Council applied for power to raise £52,350, which, it was believed, would suffice to cover all extensions for seven years. The L.G.B. has authorised the raising of the smaller sum, on the recommendation of the inspector who held the inquiry, and who somewhat rashly represented that in a few years' time the present machinery might become obsolete!

Walsall.—The E.L. Committee has recommended the Corporation to apply to the L.G.B. for a loan of £14,500 in addition to the £10,050 already asked for, in order to meet the estimated capital outlay at the electricity works for the next two years.

Wickwar.—The Parish Council has decided to approach Messrs. Arnold, Perrett & Co. with a view to the resumption of lighting the town by electricity. At present oil lamps are utilised.

Wolverhampton.—The T.C. has decided to apply for sanction to a loan of £19,000 to cover the expense of extending the E.L. mains in the town.

Worcester.—A loan of £2,351 for laying electric light mains has been applied for.

As the Bill of the Salop, Worcestershire and East Denbighshire Electric Power Co. contains a clause giving the company power to supply the whole of the county and a tramway company in the city, the Electricity Committee is to take steps to protect the interests of the Council.

Wolverhampton.—The T.C. has decided to extend the electric lighting mains at an estimated cost of £2,000, and to apply to the L.G.B. for sanction to a loan for £15,000, to cover the amount of £4,165 overspent on the last loan of £15,000, and to provide for the present and future extensions of mains. The advantage of extending mains in anticipation of a future demand is shown by the fact that since the mains were extended in Tettenhall Road every new house erected has been electrically lighted. The builders along the routes of the proposed extensions state that if the cables be extended they will wire every new house.

An interesting discussion took place recently on a proposition by the Lighting Committee that the Corporation seal be affixed to an agreement relative to the sale of four Marshall compound engines. The original cost of the engines in 1894 was £2,529, but since then an amount of £758 has been written off. The Committee wished to sell the engines for £1,200, because other engines which were used in place of them were more economical as regards coal consumption and labour. Councillor White held that they should have on the accounts of the department some indication of what was allowed on the score of depreciation. Ultimately the recommendation of the Committee was adopted.

ELECTRIC TRACTION NOTES.

Batley.—Good progress is being made at the Batley Corporation's electricity works, which are intended for both lighting and traction purposes. It is hoped that in about four months' time the Corporation will be in a position to supply current both for lighting and the running of trams. Negotiations have been proceeding for some time between the Corporation and the British Electric Traction Co. for the leasing of the lines, which the Corporation is constructing, to the company, whose Dewsbury and Spen Valley system touches Batley, but no settlement has yet been come to, and the Corporation is proceeding on independent lines.

Birmingham.—A financial contemporary says that the B.E.T. Co. has offered to purchase the Birmingham tramways on the basis of a percentage on the net receipts of the undertaking in the city and environs, with a stipulated minimum estimated at £30,000 per annum, equal to a 3d. rate. The company's object is to make its Birmingham undertaking homogeneous.

Bradford.—A somewhat acrimonious discussion is proceeding between the Electricity Committee and the Tramways Committee on the subject of the price which ought to be paid by the Tramways Committee for current, the Electricity Committee holding that the 1d. per unit paid by the Tramways Committee is quite insufficient to meet the cost of production. The newest phase of the controversy is the suggestion by the Electricity Committee that, at any rate, 4½d. per unit should be paid by the Tramways Committee for such part of the electricity as is consumed in the lighting of the cars. The Electricity Committee wishes the matter to be referred to the arbitrament of the President of the Institution of Chartered Accountants, but the Tramways Committee declines.

Burnley.—The T.C. is considering a scheme which is estimated to cost over £60,000. Three branch lines are to be laid, costing £24,000, to serve outlying parts of the town; a sum of £14,000 is needed for extensions at the principal depôt, £2,500 for new offices in the centre of the borough, and £2,000 for new offices at the depôt, in addition to a sum of £17,700 for 14 additional cars.

Carlisle.—The yearly returns respecting the electric tramways show that the receipts have advanced from £8,383 in 1901 to £9,139, an increase of £756.

Chatham.—The Chatham and District Light Railways Co. having proposed to extend its lines in the Gillingham District Council's area, the Council has considered letters on the subject from Messrs. Ashurst, Morris & Crisp, on behalf of the company, and Mr. Marshall (the company's engineer) waited on the Board and discussed the matter. The Council decided to assent to the proposed extension of the lines along Watling Street into the Rainham district. The Council also assented to a diversion of the company's lines in Old Brompton, at the scene of the recent fatal accident, caused by the overturning of a car. It is proposed to run a system of lines up Middle Street, Old Brompton, instead of at Westcourt Street, as at present laid down, and to purchase property in order to make a more safe curve. This is in order to connect the lines from Chatham and New Brompton directly the one with the other.

Clacton-on-Sea.—The dispute between the U.D.C. and the promoters of the Clacton and St. Osyth Light Railway as to whether the latter is bound by a clause in the order to take electrical energy from the Council, should the latter be in a position to supply it, has been referred to the L.G.B. for decision, prior to the confirmation of the order by the B. of T.

Colchester.—The T.C. has adopted by some 18 votes to nine an electric tramway scheme, the estimated capital expenditure being £63,414 and the estimated annual loss £300. A section of the Council were strongly averse to the proposal, and prophesied financial disaster.

Dewsbury.—Trial trips have been made on the Dewsbury and Thornhill sections of the B.E.T. Co.'s system, and everything now appears in readiness for the L.G.B. inspection, which it is expected will take place shortly.

Edinburgh.—Residents in the West End of the city have lodged a petition against the proposal to construct a line for the running of electric tramcars between Edinburgh and Queensferry, a favourite resort, whose chief attraction is the great Forth Bridge.

Heanor.—The U.D.C. has conditionally approved of the Derbyshire and Notts Light Railway scheme. The promoters have now secured the consent of the local authorities covering two-thirds of the route.

Hove.—The Council has definitely decided to oppose the B.E.T. Co. and the Brighton Corporation, both of which are applying for powers to construct tramways in Hove.

Kirkcaldy.—Following upon the lighting of the town by electricity, Kirkcaldy gave one of the electric tramcars a trial on the evening of 7th inst. It is expected that early next month the cars will be running regularly.

Lancashire and Cheshire.—The estimate for the construction of six miles of tramways in Lancashire, south of Manchester, as given by Mr. Herbert Bayley, engineer for the work, is £92,556. The tramways are to cost £82,556, and the widening of roads £10,000. The estimate for the construction of eight miles of track in Cheshire is £98,806. In this case road widenings are estimated to cost £4,000. One-third of the Cheshire lines in question will consist of single track.

Liverpool.—At a meeting of the City Council last week, Alderman Chas. Petrie, chairman of the Tramways Committee, referring to the working of the electric tramways during the past year, said that the year had been a very good one. The gross income from the trams amounted to no less than £506,626, which was £38,243 more than in the previous year. He was sure that was very satisfactory, and that every member of the Council might feel satisfied that the tramways undertaking was in every way in a most successful position. They could not exactly say until the accounts were out what the net profit would be. He believed that after providing something like £100,000 for interest and sinking fund, they would have over £70,000 of a surplus. The growth of the mileage, number of passengers carried, and receipts of the Liverpool tramways since 1897 is shown by the following figures:—

Year.	Mileage.	Passengers.	Receipts.	Increase.
1897	6,013,180	38,409,084	£290,743	——
1898	6,279,768	41,772,034	314,207	£23,464
1899	7,600,546	63,771,450	359,929	45,722
1900	9,100,866	82,967,959	417,574	57,645
1901	10,970,063	101,103,789	468,383	50,809
1902	11,790,815	109,335,525	506,625	38,243

Compared with 1901, the increases per cent. in 1902 were:—Passengers, 8·1 per cent.; mileage, 7·5 per cent.; receipts, 8·2 per cent. Compared with 1897, the last year under the control of the old company, the increases in 1902 were:—Passengers, 184·43 per cent.; mileage, 96·24 per cent.; receipts, 74·28 per cent. Alderman Petrie also stated that, out of 403 cars, 300 were fitted with the plough lifeguard. The other cars were being fitted with this guard at the rate of from eight to ten cars per week.

At the same meeting Councillor Thomas Utley moved an amendment to the general proceedings of the Tramways Committee, to the effect that, having regard to the Act passed last year for the disposal of the surplus, the city engineer report upon the estimated annual amount necessary for the renewal of the permanent way; that the city electrical engineer report upon the like amount for the overhead equipment and the electrical portion of the cars; and the general manager report upon the like amount for the renewal of the cars; and that the controller, upon such reports, advise the Tramways Committee as to the proper annual amounts to be set aside for such renewals. Speaking to the amendment, Mr. Utley said that the surplus of the Committee, without the knowledge asked for, was imaginary. Although they repaired defects here and there in the overhead equipment, they had no provision as to general depreciation, nor did they know what it was. Alderman Petrie stated that everything was kept in first-class condition out of revenue. It was not necessary, therefore, to go to the trouble and expense which the provision of the information asked for would entail.

Halesowen.—The B. of T. has asked the U.D.C. what steps have been taken to carry out the Electric Light Railway Order of 1901, and as a result the Council has asked for an extension of the Order for another year.

Manchester.—The decision of the Tramways Committee to reduce the hours of service of its employés to 54 per week has received the approved of the City Council. This and other concessions mean an additional expenditure by the Tramways Committee of £60,199 per annum when all the lines (upon which 600 cars are to be run) are in full working order. After this it is impossible to estimate, even approximately, to what extent the city rates will benefit, but the chairman of the Tramways Committee (Mr. Boyle) is of opinion that the sum still available will be a substantial one. Would it not have been better to see how the system is going to turn out before adopting such an extravagant scheme?

Mansfield.—The Mansfield and District Light Railways Co. is asking the B. of T. to sanction the alteration of gauge of its proposed lines from 3 ft. 6 in. to 4 ft. 8½ in., so as to be uniform with the gauge of the other schemes in the counties of Nottinghamshire and Derbyshire.

New York.—An American correspondent informs us that the Metal-Plated Car and Lumber Co. has secured the contract of the Interborough Rapid Transit Co. for the copper sheathing of 500 cars to be used in the subway now under construction in New York City. The metal will be left unpainted, and is designed as a protection against fire in the event of short circuiting.

Newport (Mon.).—The Newport Gas Co. have notified the Corporation that the contractor for the electric tramways has laid bare their principal main, and is about to encase it with concrete, and that they will hold the Corporation responsible for all damage and loss caused. The borough engineer is seeing the company's manager with a view to settlement.

North-Eastern Railway.—Our northern correspondent learns on high authority that the question of the tender for the electrification of the railway lines on the North-Eastern Railway, from Tynemouth to Newcastle, which is to be made into a sort of circular route, is practically settled, and that the successful contractors are, or will be, the British Thomson-Houston Co., whose tender is considered to best fulfil the conditions required, and it is anticipated that they will receive the contract for the conversion. It is stated that the system to be adopted is the third rail, and current will be supplied at 650 volts. The Newcastle-on-Tyne Electric Supply Co. are seeking power to supply the energy to the railway company. It is further said that the tender provides for the electrification of 41 miles of single track, and it is intended that the system shall be sufficient to keep 47 trains running on the circle and its branches at one time at a speed of 22 miles an hour. Each train will be capable of carrying 180 third, and 24 first-class passengers.

Norwich.—The directors and chairman of the Electric Tramways Co. entertained the drivers and conductors of the cars at dinner. There were two detachments of 120 each, one on the 6th inst. and one on the 7th inst.

Peterborough.—It is expected that the system of electric tramways at Peterborough will be opened to the public in about a month's time. The chief route has been completed, and experimental cars are running daily for the purpose of giving instruction to the drivers. The work has been carried out by the B.E.T. Co., and power is supplied from the Corporation electric works.

Poole.—The employés of the Poole and District Electric Traction Co. held their first annual supper at Upper Parkstone on Monday last week. Mr. J. S. Raworth occupied the chair. A handsome smoker's cabinet was presented to the manager, Mr. E. H. Mottram.

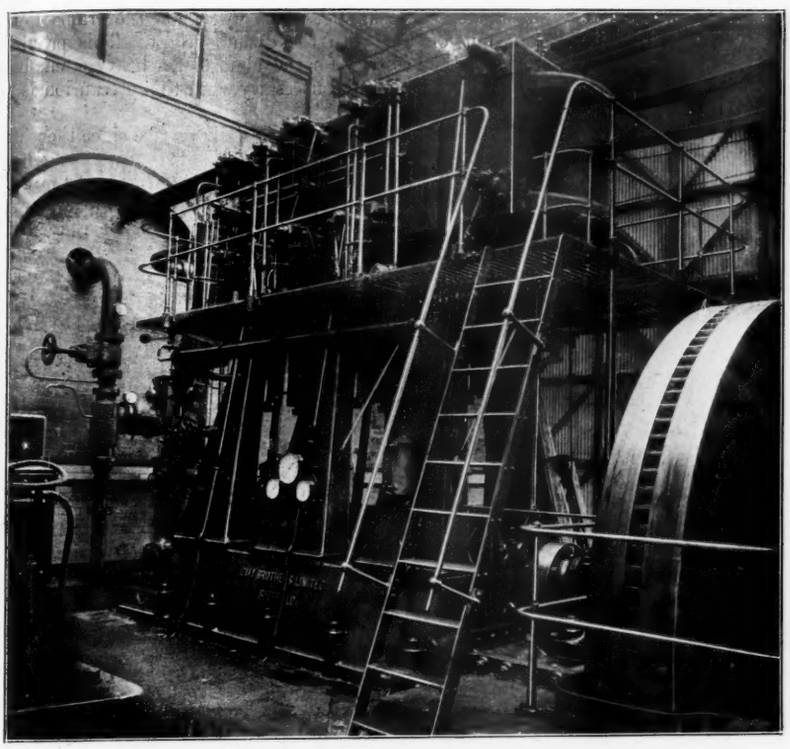
Owing, it is stated, to the fusing of a feeder cable last Saturday night, the electric tramway system was stopped for three hours.

West Bromwich.—The work of reconstructing and electrically equipping that portion of the tramways between Carters Green and Great Bridge and Tipton has now been completed, and a trial trip took place on Monday. Steady progress is being made with the Hill Top section connecting West Bromwich, near Wednesbury, and it is anticipated that will be ready for opening in a month or six weeks' time. There is every prospect of the Spon Lane and Bromford Lane sections being ready some little time later.

(Continued on page 107.)

MIDDLESBROUGH ELECTRICITY WORKS.

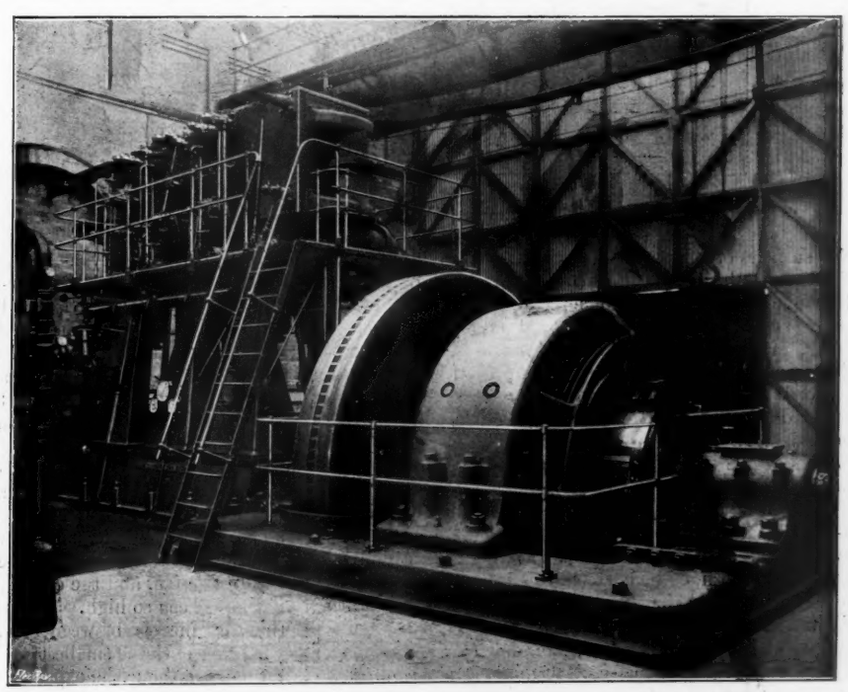
The generating plant of the Middlesbrough Corporation electricity works was constructed to the specification of Mr. Robert Hammond, the contractors for the engines and dynamos being Messrs. Davy Bros., Ltd., of Sheffield. The plant consists of one 300-kw. vertical triple-expansion Corliss steam engine driving a dynamo direct, one 100-kw. high speed compound engine driving two 50-kw. dynamos direct, and one motor-generator for charging accumulators. The dynamos were supplied by Messrs. P. R. Jackson & Co., Ltd., of Salford, and the 100-kw. high speed engine by Messrs. Browett, Lindley and Co., of Patricroft.



Triple-Expansion Davy Engine.

The engines of the 300-kw. generating set were specially designed and constructed by Messrs. Davy Brothers to meet the conditions of the guarantee, which were to deliver one kw.-hour on the switchboard for 25 lbs. of water weighed and pumped into the boilers, with 24 in. of vacuum and 160 lbs. per sq. in. steam pressure in the steam chest of the high pressure cylinder, under a penalty of £200 for every pound of water over 25 lbs., and a bonus of £200 for every pound under 24 lbs., an allowance being made for any fall of the vacuum below 24 in. The engines were to be capable of developing 350 kw. in an emergency, and to work non-condensing without any alteration to the valves or valve gear. In consideration of the amount of bonus or penalty at stake, no expense, either in design or construction, was spared which would increase the efficiency. The engines have cylinders 12½ in., 20 in. and 31 in. diameter by 30 in. stroke, and run at 120 revolutions per minute.

The cylinders are bolted up to one another and carried by three pairs of standards. The Corliss valves are all double ported, and have consequently a very short travel, a matter of the utmost importance with trip gear working at high speed. The cut-off gear of all three cylinders is under the control of the governor, and the range of cut-off in the high-pressure cylinder is from zero to 75 per cent. of the stroke. The valve gear is of special design, all the levers and pins being of forged crucible steel. The closing



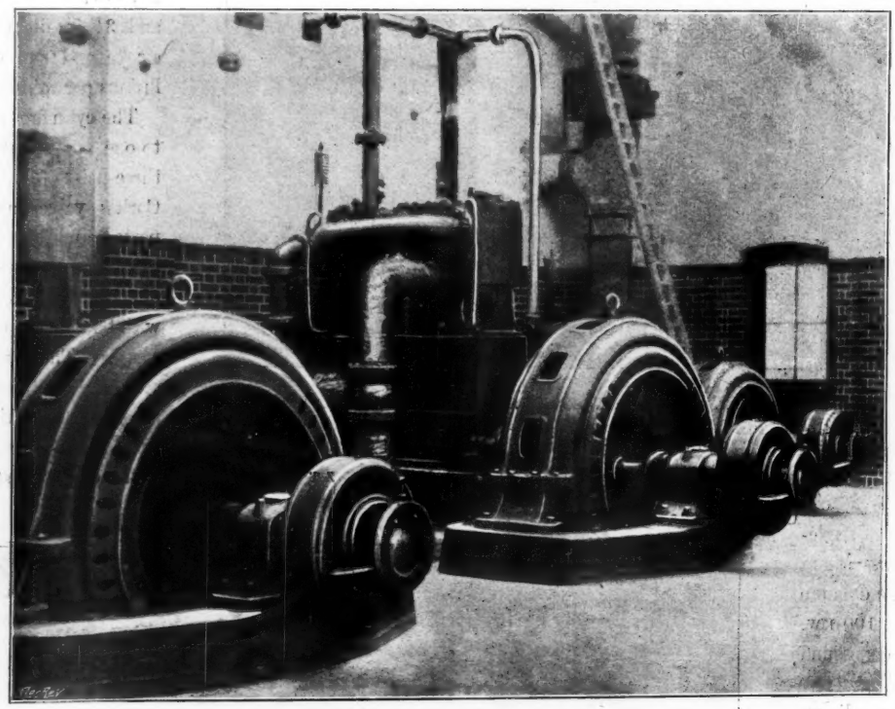
Jackson-Davy 300-kw. Steam-Dynamo.

cylinders are steam-driven and fitted with air cushions. They are supplied with steam by means of a connection to the steam main, and the pressure is adjustable by means of a reducing valve; the advantage of this is that the closing pressure can be regulated to a nicety. It also enables the weight of the moving parts to be reduced to a minimum.

The exhaust valves are driven through wrist-plate motions. This allows the valves to remain practically stationary on their seats after they are closed, and provides a very rapid opening and closing movement. The fact that the valves remain practically stationary on their seats after they are once closed, when the pressure of steam on their faces is at a maximum due to the steam pressure inside the cylinders, reduces the wear and the friction of the valves to a minimum. All the valve spindles are fitted with self-adjusting metallic packing. The cylinders are not steam-jacketed, but are fitted with renewable liners of special hard cast-iron. The clearance spaces are reduced to a minimum, and the valves arranged so as to thoroughly drain all water from the cylinders.

The dynamo is mounted, together with a fly-wheel of 17 tons weight, on a forged-steel shaft 19 in. diameter in the body, carried by two bearings, that next the engine being 14 in. diameter × 32 in. long, whereas that outside the commutator is 12 in. diameter × 32 in. long. The connection between the engine crankshaft and the dynamo shaft is by a special coupling, which will allow the crankshaft to run out of line with the dynamo shaft. This provision obviates the necessity for the abnormally heavy crankshafts which have been found necessary when this precaution is not adopted.

These engines have been in daily service since they were first put to work in June, 1901. The test on them was carried out by Mr. Hammond's own staff after 12 months' constant work on the town service, without any adjustment to the engine except some slight adjustment of the exhaust valve gear. The consumption of feed water, as weighed into the boiler and calculated for 24 in. of vacuum, shows that 19·55 lbs. were used per KW.-hour delivered on the switchboard, with a steam pressure of 158 lbs. at the stop



Erith: Three-Phase Generating Plant.

The surfaces of the pistons and cylinder covers are turned perfectly smooth, in order to reduce the clearance surface and volume to a minimum. The piston of the high-pressure cylinder is packed with an improved type of frictionless packing, suitable for the highest pressures. The intermediate and low-pressure pistons are packed with Messrs. Lockwood & Carlisle's patent rings and springs. The piston rods are forged from special high-carbon crucible steel, and are secured to the crossheads by taper cones and steel nuts. The stuffing boxes are provided with "United States" packing.

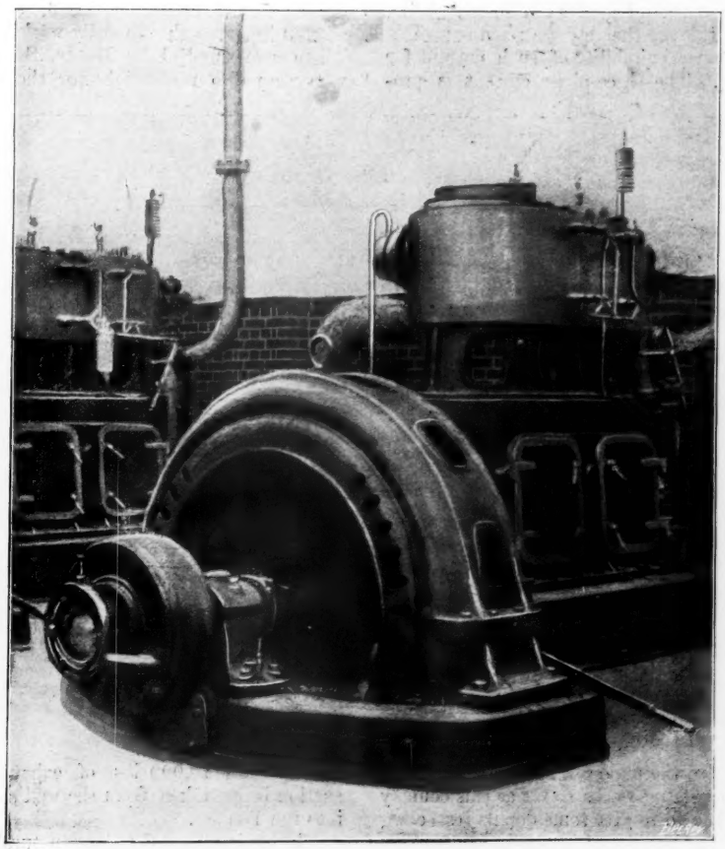
The cross-heads are of forged steel; the slippers are of cast-iron, lined with white metal. The slide bars are of a special mixture of cast-iron. The connecting rods are forged from special high carbon steel, the top steps being of phosphor bronze, and the bottom steps of cast-iron lined with white metal. The crankshaft is of forged steel of the built-up type, carried in six bearings $6\frac{3}{4}$ in. diameter × 8 in. long, with crankpins 7 in. diameter × 9 in. long. All working parts are lubricated from an overhead tank fixed on the upper platform of the engines; this tank is fitted with a row of adjustable drop sight-feed lubricators connected by polished copper pipes to all parts requiring lubrication, and is kept constantly filled by a small force pump driven from the engine, which draws oil from a filtering apparatus.

valve. This is equivalent to a steam consumption of 13·125 lbs. per indicated horse-power-hour. These results are not, it is to be remembered, based upon the amount of water collected from a surface condenser, but upon the actual amount weighed into a special tank fitted with conical ends and pumped into the boilers, and they consequently include losses which are not usually taken into account, the water drawn from the main steam pipe traps only being deducted.

The engines are designed to give a maximum *combined* efficiency, and the consumption of steam per indicated horse-power-hour, namely 13·125 lbs., might have been considerably reduced by the adoption of larger engines, but this would have been at the expense of a very material increased loss in friction, and the combined efficiency would certainly not have been so high. The number of expansions used in these engines is between 10 and 11 to get the best results, whereas to get the smallest steam consumption per indicated horse-power-hour the expansions would require to be between 20 and 25. This would not only necessitate engines about 50 per cent. larger in size, but would necessitate completely steam jacketing the cylinders and fitting intermediate steam-heated receivers, which would have added greatly to the cost and complication, and would certainly not have given such good results.

The dynamo, as already stated, was built by Messrs. P. R. Jackson & Co., and is rated at 300 KW. nominal load; it is capable of giving an output on emergency of 350 KW. for two hours, at 440 to 500 volts. The field is six-polar, and the magnet frame is of special cast-steel of the firm's own manufacture. The armature is 6 ft. in diameter, and the commutator 4 ft. 6 in., with a brush surface $11\frac{3}{8}$ in. long. The spider of the armature is extended to form a coupling with the engine fly-wheel.

The temperature rise above that of the surrounding atmosphere after the official test run at full load for 10 hours was 51·5° F. in the armature, 57° F. in the field magnets, and the commutator was quite cool. The armature is wound according to the Sayers and Jackson patents, and the full load was thrown on and off with the brushes fixed in one position, without the slightest sparking or trouble of any kind.

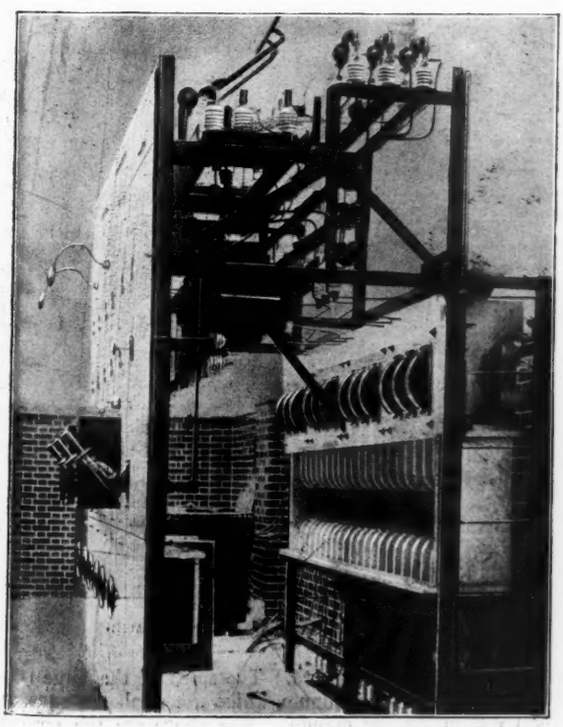


ERITH: INTERNATIONAL-ALLEN GENERATING SET.

The two small dynamos are each of 50-KW. output, at 220—250 volts, 420 revolutions per minute; the fields are of the two-pole type, of cast-steel, and the armatures have slotted cores, wound like the larger ones, and equally free from sparking with fixed brushes. Messrs. Jackson also supplied a motor generator, taking current at 440—500 volts, and generating 100 amperes at 20—250 volts, 800 — 900 revolutions per minute. The set consists of two similar two-pole overtype machines mounted on a common base-plate, which, with the magnets, is of special cast-steel.

The maximum temperature rise of these machines was guaranteed not to exceed 60° F. after 10 hours' run at full load.

The whole plant has run from the commencement without a hitch of any kind.

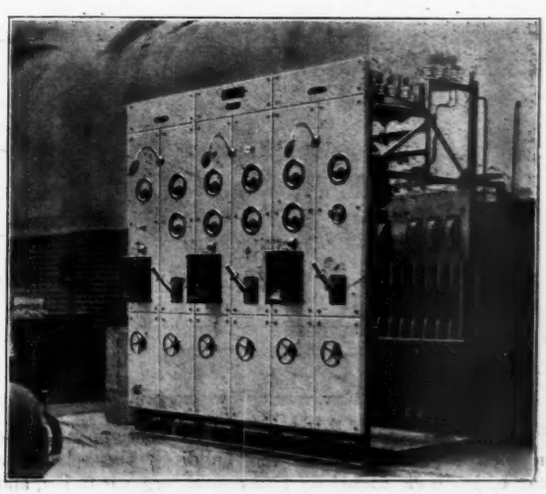


ERITH: INTERIOR OF SWITCHBOARD.

THE ELECTRIC LIGHTING OF ERITH.

[A THREE-PHASE PLANT.]

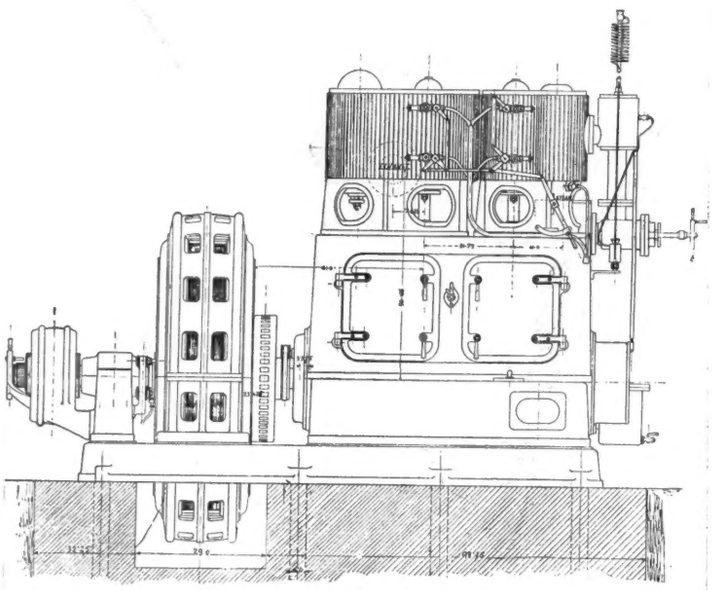
ON Monday last with the customary public ceremony the electric light and power supply system of the Erith Urban District Council commenced operations. There are several specially noteworthy points in connection with the under-



ERITH: FRONT VIEW OF SWITCHBOARD.

taking, and the most prominent of all is the adoption of the three-phase alternating system of generation in a lighting works; the reasons for this are the very scattered nature of the district and the greater suitability of such current for power supply purposes. The three-phase current is produced at 3,000 volts, and at this high pressure it is conveyed along feeders to certain points in the supply area, where by transformers the necessary change is made to obtain a low pressure supply for consumers' premises, viz., 200 volts for lighting and 350 volts for power.

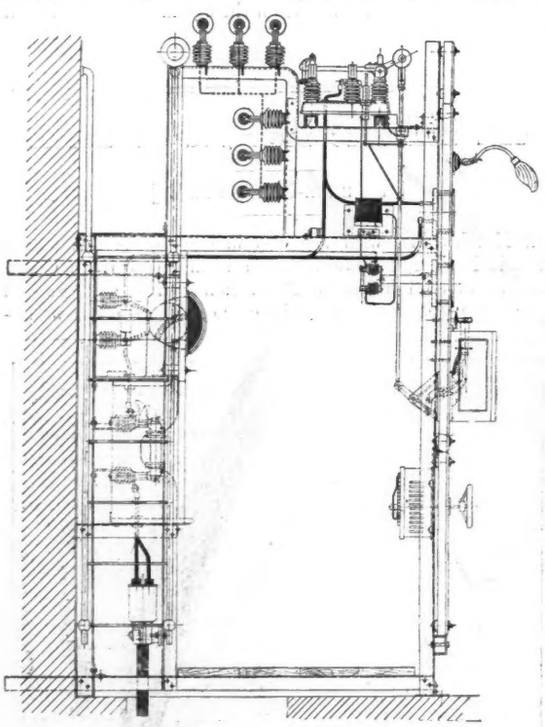
It is just about two years since the Council resolved to adopt a municipal electric lighting scheme, and appointed Mr. W. C. C. Hawtayne as its consulting electrical engineer. In April of that year (1901) the contracts were placed.



Elevation of Steam Alternator.

Having thus introduced the undertaking, which has been rightly described as a pioneering works so far as this country is concerned, we will proceed to give some details respecting the machinery.

The station stands on the Walnut Tree House estate, and on the appropriated site there is ample room for accommodating a possible dust destructor and proposed tramway car sheds. The site is excellently situated both in respect of its rail and water facilities and its contiguity to the municipal offices. As to the buildings themselves, no money has been wasted on unnecessary ornamentation, and the temporary end wall will be easily "knocked out" when extensions of machinery become requisite.



End Elevation of Switchgear.

The boiler house equipment comprises two Lancashire boilers, capable of evaporating 6,000 lbs. of water per hour at 200 lbs., though the daily working pressure is 160 lbs. These were supplied by Messrs. Spurr, Inman & Co., Ltd., who were also responsible for the supply of the fittings, these being of their own and Messrs. Templer & Ranoe's manufacture. Safety, isolating and other valves are, of course, provided, and there are two feed pumps—one electrically and the other steam driven — to supply 1,500 gallons each per hour. A Green fuel economiser is, as usual, placed in the main flue. The pipe work was done by Messrs. Babcock and Wilcox, Ltd., and consists of lap-welded mild steel steam pipes with wrought-steel flanges, and cast-iron exhaust pipes. The Wheeler Condenser and Engineering Co. have installed an independent surface condensing plant to deal with 10,000 lbs. of exhaust steam per hour, the suction being taken from the well and the discharge going into the Thames.

The engine house details are naturally of greater interest in such an installation as this. This part of the work was placed in the hands of the International Electrical Engineering Co., of London and Liège. They have installed three steam alternators, two of 125 KW. each, and one of 50 KW., direct coupled to vertical compound self-lubricating non-condensing engines, constructed by Messrs. W. H. Allen, Son & Co., Ltd., of Bedford. The speed of the large sets is 375 revolutions per minute, whilst the small set runs at 500 revolutions per minute. The above are the normal outputs, but each set is constructed to be capable of developing an emergency load 20 per cent. in excess of the normal full

Laying Callender Cables at Erith.

load. The alternators are of the International Co.'s latest type, and they have a frequency of 50 cycles per second. The field magnets form the revolving parts of the machines. They are composed of cast-steel poles, wound with amply insulated high conductivity copper wire, the insulation being coated with insulating varnish to protect it from oil and water. The armature coils are "star" connected and highly insulated, whilst provision is made for the rapid temporary cutting-out of any defective coil in case of emergency. The current density in the armature is less than 2,000 amperes per sq. in., and in the field magnets less than 1,000 amperes per sq. in. To each alternator is fitted a direct-driven six or four-pole shunt-wound exciter dynamo. The alternators are arranged so that they can be easily switched into parallel without requiring the use of an artificial load, and run perfectly in parallel at all loads with a low synchronising current.

The switchboard was constructed by the same company, and has all their latest improvements, no material of a combustible nature being used. A white marble panel, 2 in. thick, is provided for each set or circuit, which is entirely confined to its own panel, so that a failure or breakdown on any section would not interfere with or endanger the proper working of any other section. The board is arranged for three alternators with their exciters, and four outgoing circuits, and admits of any alternator being separately connected to any circuit. No part of the front of the board carries a high pressure, so that there is no danger from shocks. The high-pressure quick-break three-pole switches employed are very interesting. The blades are operated by an arrangement of levers, and are fitted with a device to prevent the continuation of an arc when the circuits are opened. The handles are fitted with spring synchronising contacts, and the lever is arranged for three positions, "off," "synchronising" and "on." The high-pressure fuses, which serve also as auxiliary switches, have porcelain handles, which work easily, and are provided with the same arcing device as mentioned above. The feeder circuits have in each phase an "edgewise ammeter," and a handle fuse as described above. They are separated from one another by marble slabs. From the illustrations which we are able to give a very good idea may be obtained of the main and feeder switchboards.

There are two switchboards, one mounted behind the other —one carrying the switch handles and recording instruments and the synchronising gear, while the other, that at the rear, carries the gear, &c., for the outgoing main cables.

Only two details remain to be mentioned in connection with the station, and they are that the overhead travelling crane was supplied by Messrs. Carrick & Ritchie, and that the station lighting was carried out by Messrs. H. E. Keen and Co.

The mains and public lighting contract was placed with Callender's Cable and Construction Co., whose works, by the way, are located in the area of supply, and are to take a considerable amount of power from the public mains for driving some of their departments, about 100 H.P., we believe, at first. Messrs. Callender have supplied three-core paper-insulated steel-armoured feeder cables, which are laid in wooden troughing filled in with refined Trinidad bitumen and covered with tiles. The distributing mains are similar in construction and laying, and are made up into two, three and four-core cables. For the public lighting two core lead-sheathed and steel-armoured cables are laid direct in the ground. The mains originally contracted for have been considerably added to, and at the moment the work in hand represents about 14,260 yds. of feeders, 5,400 yds. of distributors, and 46,000 yds. of public lighting cables. Distributors are laid to serve a number of streets in Erith, Northumberland Heath and Belvedere.

The street lighting is done by 2,000 nominal C.P. Oliver arc lamps in the principal thoroughfares, and in the other streets, which are now lighted by means of oil lamps, there will be a gradual change over to Nernst lamps during the next few months.

The Council is energetically bringing the claims of electric light and power under the notice of the inhabitants, and, if Parliament will permit, an "assisted" house-wiring scheme will shortly be introduced, with a view to increasing the popularity of the supply.

In conclusion, we should mention that Mr. Harold Hind acted as architect; Mr. George E. Heath is the resident electrical engineer; and we are indebted to Mr. W. C. C. Hawtayne for his courteous assistance in the preparation of the foregoing particulars.

Mr. George W. Brodie is the chairman of the Electric Lighting and Tramways Committee, the other members of which are Messrs. H. Cannon, Wm. Charlesworth, Alfred Gregory, Robert Johnston and P. W. Masson.

ELECTRIC TRACTION NOTES.

(*Concluded from page* 102.)

Ravensthorpe.—Arrangements have been made between the National Telephone Co., the British Electric Traction Co., and the Ravensthorpe Urban District Council to lay the telephone wires through Ravensthorpe underground. The B.E.T. Co. are to contribute towards the cost.

Rochester.—At a special meeting of the T.C. the provisions of a Bill to be promoted in Parliament during the coming session, giving the Corporation powers to lay down a system of tramways in the city and the Parliamentary district of the borough, were read and agreed to. It was also decided to affix the seal of the Corporation to memorials against the Bills of the Rochester Chatham, Gravesend and Maidstone Tramways (promoted by the Kent Electric Power Co. and Syndicate), and also that of the Chatham and District Light Railways Co. These latter companies are also seeking for powers to run tramways over the Rochester district, and the Rochester Corporation is anxious to hold the control of its own streets in the matter of trams.

St. Annes.—The U.D.C. has decided to inform the Blackpool, St. Annes and Lytham Tramway Co. that they will be prepared to supply energy for traction and lighting purposes on the following terms: Traction, up to 450,000 units per annum, 2d. per unit; exceeding this amount, 1½d. per unit, with 10 per cent. rental on the cost of the feeder to the company's sub-station, the company guaranteeing a minimum of 350,000 units a year, including current for traction and lighting; arc lamps, £19 per annum. To provide this supply the plant will have to be increased, and a loan of £12,023 has been applied for.

St. Helens.—The St. Helens County Borough Council have decided to oppose the Bill of the South Lancashire Tramways Co. now pending in Parliament.

The T.C. has decided to repudiate all liability in connection with a claim for damage and loss sustained by the tramways company owing to the failure of the supply of energy at various times.

Salford.—The B. of T. has sanctioned the T.C.'s proposal to borrow £59,440 for the reconstruction and electric equipment of the tramways within the Swinton and Pendlebury district.

South-East Lancashire.—Negotiations are in progress between the municipal authorities of Manchester, Bolton and Bury, which are expected to result in greater travelling facilities between these towns. It is proposed to effect a junction of the Bury and Bolton tramway systems at a place called Black Lane, thus adding a link to prospective connection with Yorkshire; also to provide for the transport of cotton and bleaching goods between Manchester and Bolton, and to secure a parcels delivery service between the several towns and the intervening districts. The difficulty with regard to interchange of tramway traffic between Manchester and Salford, so long as it remains unsettled, will interfere with the full development of the scheme, as a length of Salford line occupies a part of the route. The public has learned with satisfaction that further efforts are to be made to put an end to the dead-lock with Salford. For the greater part of the year there has been no through communication between the city and Salford by tram, each municipality having its terminus on the boundary line which separates them, and residents on both sides have suffered the greatest inconvenience. Now a joint committee is honestly endeavouring to effect an amicable settlement.

South Lancashire Trams.—Negotiations are proceeding between the Tramway Committees of Bolton, Manchester, Bury and South Lancashire, with a view to effecting a junction of the Bolton and Bury trams at Black Lane, and also with a view to the introduction of a goods service on the tramways between Manchester, Bolton, and other towns in the district.

Southend.—During the nine months ended December 31st the Corporation tramways carried 2,242,236 passengers, and the receipts amounted to £11,400. There were 264,783 car-miles run at a cost of 2·50d. per mile. The four sections cover 7¼ miles.

Sunderland.—On Saturday night, the 10th inst., two of the overhead wires of the tramways at Sunderland were broken accidentally. The car coming from Tatham Street travels as far as the corner of High Street West and Fawcett Street, and there the trolley is changed, and the car returns over the course. About 8 o'clock a car was leaving Fawcett Street corner for Tatham Street when the trolley sprang off the wire, and engaging in one of the

span wires, which at this point carry the overhead wire, caused two of the wires to snap. The wires fell to the ground, but, fortunately, without striking anyone. A woman named Mrs. Watson attempted to leave the car when the wires were broken and got on to the platform of the car, but on taking hold of a stanchion, which apparently was in connection with one of the fallen wires, she received a somewhat severe shock, and was thrown violently to the ground. So far the effects do not appear to have been very serious.

Swansea.—The Swansea Tramways Co. has written to the Tramways Committee, pointing out that, when it agreed to take a lease of the proposed new tramlines, there was no thought, either in its mind or in the mind of the Council, of adopting surface contact traction. The company claims to be consulted in the matter, and the Committee has accordingly invited it to express its views.

Worcester.—The Worcester Tramways, Ltd., has informed the T.C. that the company has been voluntarily wound up, and had agreed for the sale of its whole undertaking to the Worcester Electric Traction Co., Ltd, which had a capital of £120,000. The new company has agreed to pay the Electricity Committee for current for the first year, 2d. per unit for 200,000 units. The Corporation has assented to the transfer of the undertaking.

Yeadon.—At Yeadon on January 8th a conference of the Guiseley, Yeadon and Rawdon U.D.C.'s was held to consider the scheme of the London and Birmingham Trust, Ltd., to construct electric tramways from Kirkstall (Leeds boundary) to Guiseley. Mr. Le Maitre, on behalf of the engineers, stated that if Horsforth U.D.C. secured powers to construct tramways in its own district, the Trust would proceed with other sections of the scheme. The local authorities will have the option of purchase at either 35 years (on the profits of three subsequent years) or 42 years. A resolution was unanimously passed supporting the scheme.

TELEGRAPH AND TELEPHONE NOTES.

Competitive Telephony.—At the last meeting of the Hamilton (Ontario) City Council the proposed formation of a new telephone company in this city was referred to. A special committee of the City Council had fully investigated the matter of telephone competition, and the Committee's report was strongly against competing telephone services. The Committee's conclusions were as follows:—"Your Committee has set out fully the facts as it found them in all places visited, and upon these facts the following conclusions are arrived at: It is not desirable for any community to have competition in telephones, unless it is to regulate some very grave evil. The almost universal experience has been that competition raises the rates materially to business and professional men, and lowers the rates somewhat to a resident. Competition in ordinary lines of business may be a good thing, but your Committee is of opinion that in telephony the rates should be regulated by some other means, competition being costly and up to the present time somewhat in the nature of an experiment. Government ownership of the telephone trunk lines, with local ownership of the local lines, would be one solution of the difficulty, and probably the very best solution. Absolute Government control of all telephone lines would be another solution. Government control of the rates would probably be the most natural solution of the present state of affairs in Canada. If the Government controlled the trunk lines, the municipalisation of the local lines would be a comparatively simple matter; but with the trunk lines in the hands of the Bell Co., and also the local lines in the hands of the Bell Co., the installation of a municipal plant would be merely the introduction of competition."

French Telegraphs.—The *Matin* announces that M. Berard, Under-Secretary of State in the Department of Posts and Telegraphs, intends to lay before the Chamber on its re-assembling a Bill opening credits for the construction of two telegraph lines connecting Brest with Dakar, and thence with Madagascar, Réunion, and Mauritius.

Newport (Mon.) Telephones.—A Committee has been going into the question of a municipal telephone scheme which is estimated by an expert to cost £12,000 for 1,000 subscribers, and to produce £3,536. The Committee is not prepared to recommend a municipal system, but would consider an application from another company to compete with the existing service.

Paris—Rome Telephones.—The Paris correspondent of the *Evening Standard* says that in a few days the new telephone circuit between Paris and Rome will be inaugurated.

Postal Telegraph Co.—The late Mr. John W. Mackay made provision in his will for a considerable sum of money to be divided among the employés of the Postal Telegraph Co., New York, length of service to be considered by the trustees when awarding the legacies.

Telegraph Rates to Demerara.—An evening paper says that the secretary of the West India and Panama Telegraph Co. has informed the West India Committee that since July, 1899, the tariff from Demerara to Great Britain has been reduced from 15s. 0½d. to 7s. 0½d. per word without in the least increasing the volume of traffic.

The Telegraph Wire Export Trade.—December proved to be a fairly active month as regards the export trade of the country in telegraph wire and apparatus connected therewith, the shipments reaching a value of £106,591 which compares with £70,900 in November last, and only £37,572 in December, 1901. Turning to the returns for the whole of the past year, these show that the activity recorded in 1901 has not been maintained, the exports in 1902 having amounted to only £2,835,905, as against £3,147,985 in the preceding 12 months.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	.. June 20, 1899	.. ..
Trinidad-Demerara No. 1	.. Aug. 27, 1900	.. ..
Dominica-Martinique	.. May 7, 1902	.. ..
St. Lucia-Martinique	.. May 7, 1902	.. ..
Guadeloupe-Martinique	.. May 7, 1902	.. ..
St. Lucia-St. Vincent	.. Nov. 18, 1902	.. ..
Martinique-Puerto Plata	.. July 10, 1902	.. ..
Guantanamo-Wole St. Nicholas	.. Aug. 4, 1902	.. ..
Cayenne-Pinheiro	.. Aug. 13, 1902	.. ..
Assab-Massowah	.. Dec. 30, 1902	.. ..
Reissi-Issa-Reissi-Yemani	.. Oct. 23, 1902	.. ..
Cadiz-Teneriff	.. Nov. 3, 1902	.. ..
St. Jacques-Haiiphong	.. Jan. 3, 1903	.. ..
Falmouth-Bilbao	.. Dec. 18, 1902	.. ..
Jamaica-Colon	.. Dec. 31, 1902	.. ..
Landlines:—		
Route to Tientsin and Taku *via* Helampo	.. June 18, 1900	.. ..

Wireless Telegraphy.—The Telegraph Battalion at Berbera will keep the British columns, as they advance against the Mullah, in touch with the British vessels anchored at Berbera by means of wireless telegraphy.

It is stated that the headquarters of First Army Corps at Aldershot and the headquarters of Channel Squadron were brought into close touch on 12th inst. by means of a most successful experiment in wireless telegraphy carried out between the Royal Engineers on the Long Valley and H.M.S. *Vernon* off Whale Island, Portsmouth.

CONTRACTS OPEN AND CLOSED.

OPEN.

Atherton.—January 23rd. Switchboards, transformers, pillars and cables. See "Official Notices" January 2nd.

Batley.—February 2nd. Feeders, cables, conduits, arc light columns, &c., station wiring, instruments, &c., steel poles and overhead equipment, and switchboard. See "Official Notices" January 9th.

Bermondsey.—January 19th. Lamp columns, arc and incandescent lamps, switch pillars, &c. See "Official Notices" January 2nd.

Bradford.—January 24th. The Corporation are inviting tenders for steel girder tram rails, and for 230 steel poles for overhead equipment.

Brighton.—January 26th. Overhead construction and equipment for tramways. See "Official Notices" January 9th.

Bulawayo.—February 26th. Establishment and working of an electric tramway. See "Official Notices" Nov. 21st.

Bury.—January 26th. Traction accumulators and reversible booster. See "Official Notices" January 9th.

Cardiff.—January 29th. Twenty double-deck, single truck cars. See "Official Notices" to-day.

Cleckheaton.—January 24th. The U.D.C. wants tenders for motor booster. See "Official Notices" January 9th.

Colchester.—January 17th. Wiring, &c., for Essex and Colchester Hospital. See "Official Notices" December 26th.

Darlington.—February 13th. Lancashire boiler, piping, feed-heater, traction feeders, permanent way construction, &c. See "Official Notices" to-day..

Dundee.—January 17th. Electric lighting switchboard, boosters, balancers and switch gear for the Corporation electrical power station. See "Official Notices" January 2nd.

Dundee.—January 22nd. Electricity meters. See "Official Notices" to-day.

Epsom.—January 24th. Lead covered-cable, &c. See "Official Notices" to-day.

France.—January 22nd. The French Post and Telegraph Authorities in Paris are inviting tenders until the 22nd inst. for the supply of a quantity of electric cables. Particulars may be obtained from Le Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris, to whom tenders are to be sent.

Germany.—January 30th. The Prussian State Railway Authorities at Hanover are inviting tenders until the 30th inst., for the supply of 96 tons run of telegraph wire, 10 kilometres of bronze wire, and 46,000 porcelain insulators. Tenders are to be sent to Die Direction, Die Königl. Eisenbahnen, Hanover, whence particulars may be obtained.

Guayaquil.—February 12th. The terms for the contract for lighting the city appeared in this column on January 2nd.

Hackney.—February 12th. 1,500-KW. steam dynamo and condenser, with electrically-driven pumps. See "Official Notices" January 9th.

Halifax.—The electrical engineer has been instructed to obtain tenders for the supply of a Board of Trade panel fitted with the necessary testing instruments.

Hull.—January 21st. 15 double-deck single-truck cars, equipments and top covers. See "Official Notices" January 2nd.

Ipswich.—January 23rd. 26 electric cars, also one for street cleaning, watering and sanding. See "Official Notices" January 2nd.

Newport.—January 26th. Telephones, street pillars and 30 exchange boards for tramway system. See "Official Notices" January 9th.

St. Annes-on-Sea.—January 21st. Boilers, feed pumps, steam dynamo and switchboard. See "Official Notices" January 9th.

Spain.—January 23rd. Tenders for the concession for the electric lighting of the town of Alcaniz during a period of 10 years. Tenders to El Secretario del Ayuntamiento del Alcaniz (Teruel), whence particulars may be obtained.

Spain.—January 25th. Tenders are being invited until the 25th inst. by the Spanish Post and Telegraph Authorities in Madrid for the establishment of a telephone line between Madrid and L'Escorial. Tenders are to be sent to La Direccion General de Correos y Telegrafos, Calle de Carretas, 10, Madrid, whence particulars may be obtained.

Stalybridge.—February 2nd. Electric tramcars with trucks and equipment complete, tower-wagons, overhead equipment and car sheds. See "Official Notices" January 9th.

Stockport.—January 24th. 645 tons of grooved steel tram rails, 15 tons tie bars, also special work. See "Official Notices" January 2nd.

Sydney.—January 28th. Arc lamp pillars, brackets, arc lamps, controlling gear, &c. See "Official Notices" Jan. 9th.

Tynemouth.—January 31st. Traction batteries and reversible booster.

Wellington, N.Z.—January 21st. Supply and installation of all material, including power house equipment, overhead work, track work, feeders, tramcars, &c., for tramways. See "Official Notices" December 12th.

West Ham.—January 27th. The Council wants tenders for accumulators. See "Official Notices" January 9th.

West Ham.—February 10th. Electrical equipment of 8 miles of track. See "Official Notices" January 9th.

CLOSED.

Brighton.—The T.C. received the following tenders for the construction of the permanent way and wood paving for the extension round the Old Steine and along London Road:—

	£
A. Krauss & Son, Bristol (*incomplete*)	10,287
J. J. Robson, Newcastle-on-Tyne (*ditto*)	11,555
W. L. Meredith, Gloucester (*ditto*)	11,966
E. Alcott, Westminster (*accepted*)	24,984
W. Griffiths & Co., Ltd., London	25,937
Acme Wood Flooring Co., London	26,147
J. G. White & Co., London	27,349
Dick, Kerr & Co., London	28,595
J. Brunton, Hull	29,192
J. A. Ewart, Westminster	30,313
A. Graham & Sons, Huddersfield	32,022
R. W. Blackwell & Co., London	33,190
E. Nuttall, Manchester	34,410

Cleckheaton.—The U.D.C. has accepted the tender of Messrs. I. & B. Umpleby, of Cleckheaton, for the supply of two Lancashire boilers for the electricity works.

Devonport.—The Corporation Tramways Committee has accepted the tender of Messrs. R. W. Blackwell & Co., Ltd., for the overhead equipment of the tramways at £3,795.

Frome.—The U.D.C. has accepted the tender of Edmundson's Electricity Supply Corporation for the construction of the proposed electric lighting works at £20,156.

Heckmondwike.—The U.D.C. has accepted the tender of Messrs. Robey & Co., Ltd., for the supply of a steam vertical boiler for the electricity works.

Horbury.—The U.D.C. has accepted the tender of the Horsfall Destructor Co., Ltd., for the supply of a refuse destructor plant and buildings at £1,220.

Italy.—Messrs. Philips & Co., of Eindhoven, Holland, have contracted with the Royal Italian Navy for the supply of over 100,000 electric incandescent lamps during 1903. We are informed that there were eight tenderers, including representatives of Austrian, German, French and Italian works.

Newcastle-on-Tyne.—Messrs. Bruce Peebles & Co. are to supply a 1,000-H.P. traction dynamo for direct coupling to a high speed engine.

At a meeting of the Tramways Committee held on the 8th inst., the tender of Messrs. Beeby & Co., Lancashire, for four new boilers at the power station was accepted for £2,810 each, the tenders of Messrs. Mather & Platt, of Manchester, for the supply of mechanical stokers and weighers at £1,060, economisers £608, for 12 superheaters for £3,090, and for pumping plant for £1,405, were accepted. With reference to the tenders for the boilers it was stated that several local firms had been asked to tender, and the reply received was that they were too busy and could not quote. At a meeting of the City Council on the 7th inst., Mr. Cail moved the acceptance of the tender of Messrs. Vaughan & Dymond for the extension of the boiler house at the power station for £2,000. The tender was not the lowest, but in view of the weight of iron to be employed, and the convenience of the design, it was the most satisfactory.

Newport (Mon.).—The Corporation has given an order for hoppers, boiler valves, &c., to Messrs. W. & T. Avery, Ltd., at £250; for extensions to boilers, to Messrs. J. Lysaght, Ltd.; and for motor starting and booster interchanging panels, &c., to Messrs. Spagnoletti & Co., at £104 10s.

Pontypridd.—Mr. Wilson has been appointed expert by the D.C. to submit a statement showing the liabilities of the Council in connection with the electric light and tramway scheme, and the estimate of total cost. The tender of Messrs. Hughes and Stirling, at £18,876, for the generating station buildings has been accepted conditionally. The Tudor Accumulator Co. was given the contract for the storage battery at £3,061. It has been further resolved "that the alternative tender of Messrs. Robert W. Blackwell & Co., London, at £24,233, for the permanent way in connection with the proposed tramways be accepted, subject to their agreeing to modify their tender with respect to wood-paving being used in Taff Street, &c., and that the tender of Messrs. Carrick and Ritchie, at £208, for a traveller for the destructor and engine room be accepted."

Pretoria.—Through the Crown Agents for the Colonies, Messrs. D. Bruce Peebles & Co. have secured the contract for 73 electric motors—varying in power from 3 to 15-B.H.P.—for the new Government Railway shops in Pretoria.

Swindon.—The T.C. has accepted the tender of Messrs. Steel Bros., of Swindon, for the wiring of the Town Hall at £256.

Walsall.—The T.C. on Monday accepted the tender of Messrs. Thomas Parker, Ltd., for supplying two transformers for the sum of £2,253.

FORTHCOMING EVENTS.

Friday, January 16th.—At 8 p.m. Institution of Civil Engineers. Students' Meeting. Fifth annual lecture by Prof. W. C. Unwin. Subject:—"The Measurement of Water."

At 8 p.m. Institution of Electrical Engineers (Dublin Section). Meeting at the Royal College of Science. Papers on "Railway Carriage Lighting by Electricity—J. Stone & Co.'s System," by J. H. Dowling; "Note on Electrical Time-Service," by F. Hope-Jones.

At 9 p.m.—Royal Institution. Prof. Dewar on "Low Temperature Investigations."

At 10 a.m.—Institution of Electrical Engineers (Students' Section). Visit to the works of the India-Rubber, Gutta-Percha and Telegraph Works Co.

Saturday, January 17th.—At 3 p.m. Junior Institution of Engineers; visit to new electricity works of Shoreditch Borough Council, at Whiston Street, Haggerston.

Tuesday, January 20th.—At 8 p.m. Institution of Civil Engineers. Paper to be further discussed:—"Electric Automobiles," by H. F. Joel.

Wednesday, January 21st.—At 3.30 p.m. Institution of Electrical Engineers (Birmingham Local Section). Visit to the General Electric Co.'s Witton works. At 7.30 p.m.—Meeting at the University. Paper on "Gas Engines for Electric Lighting," by H. B. Graham. At the conclusion of the meeting, the Secretary will show the Nodon Electric Valve or electrolytic rectifier furnishing direct current from alternating supply.

At 8 p.m. Society of Arts. Meeting. "The Metric System," by A. Sonnenschein.

Thursday, January 22nd.—At 8 p.m. Institution of Electrical Engineers. Discussion on the Metric System, to be opened by Mr. Alex. Siemens, Past-President, in favour of the Metric System, and by Sir Frederick Bramwell, Bart., F.R.S., in favour of the British System.

Friday, January 23rd.—North-East Coast Institute of Engineers and Shipbuilders. Meeting at Newcastle.

Saturday, January 24th.—At 7.30 p.m. Glasgow Technical College Scientific Society, at 38, Bath Street. Paper by D. Burns on "Application of Electricity to Mining."

LEGAL.

EMPLOYERS' LIABILITY.

IN the King's Bench Division of the High Court of Justice on Wednesday the case of Isaacson and another *v.* the New Grand (Clapham Junction), Ltd., came before the Lord Chief Justice, Mr. Justice Wells and Mr. Justice Channel. In this case both the plaintiffs and the defendants had lodged appeals in a complicated and protracted litigation under the Employers' Liability, Lord Campbell's, and the Workmen's Compensation Acts. An action was, in the first instance, brought under the Employers' Liability and Lord Campbell's Acts by the relatives of a young man named Isaacson to recover damages laid at £300 for his death, which took place at the defendant company's theatre at Clapham Junction, where he was engaged in looking after the engines which were used in connection with the electric lighting installation. The accident took place as far back as July 31st, 1901, when the deceased was testing a tube in order to see whether there was any obstruction in it. In order to give himself room to insert a rod in the tube, Isaacson stepped back, and fell into a sunk well filled with steam and hot water, and was scalded to death. Upon the first hearing of the case in the Westminster County Court, the Deputy-Judge non-suited the plaintiffs on the ground that there was no evidence that Isaacson was a workman within the meaning of the Employers' Liability Act. Thereupon the plaintiffs' counsel applied to the Deputy-Judge to assess compensation under the Workmen's Compensation Act of 1897, but he declined to do so on the ground that the theatre was not a factory. Against this decision an appeal was still pending in the Court of Appeal. The plaintiffs also appealed to this Court against the Deputy-Judge's judgment of non-suit, and as a result, a new trial was ordered. The case on the second occasion came before Judge Woodfall, sitting in the Westminster County Court, and for the plaintiff it was urged that the accident was caused through a defect in the ways, works, plant, or machinery, &c., from the position of the sunk well. It had to be uncovered to get the water away quickly enough. It was also said that there was negligence on the part of one of the defendants' officials. The learned Judge, however, declined to allow the case to go to the jury, and again non-suited the plaintiffs on the ground that there was no evidence of negligence on the part of the defendants. Against this decision the plaintiffs now appealed, while the defendants lodged a cross appeal, the substantial point raised by which was that the plaintiffs were altogether precluded from going on with their action under the Employers' Liability and Lord Campbell's Act, because after the first nonsuit they had exercised the option given them under the Workmen's Compensation Act, and had asked the Judge to convert himself into an arbitrator and assess compensation under that Act. Having thus chosen their remedy, it was said they lost their right to continue their action or the appeal with respect to it.

Mr. Moyses appeared for the plaintiffs, while Mr. S. T. Evans, K.C., and Mr. Minton Senhouse represented the defendant company.

Mr. MOYSES submitted that the learned judge was clearly wrong in withholding the case from the jury, and argued that the decision of the Deputy Judge upon the action having been erroneous plaintiffs were not deprived of their remedy, because they had as an alternative, in consequence of the mistake, made an application under the Workmen's Compensation Act.

Mr. EVANS, on the other hand, said the defendants were a limited company, who had employed a competent architect to design these premises, and he had placed the sunk well where it was. The company therefore had not been guilty of any negligence, and the County Court Judge was right in so holding. The deceased, moreover, knew the position of the sunk well, and knew that it was open, and yet he stepped back into it. His death was the result of pure accident, for which no one was liable. The plaintiffs had, he submitted, lost their right to continue this action by electing to proceed under the Compensation Act.

Mr. Justice WELLS said the plaintiffs were forced to exercise their option by the erroneous decision of the Deputy County Court Judge, and if that decision was set right justice would not be done unless they were placed in the same position as they were in before.

The LORD CHIEF JUSTICE, in giving judgment, said he very much regretted the course of the litigation, and even now he hoped the parties would see that compensation was assessed on the basis of the Workmen's Compensation Act. It certainly was a most unfortunate position which now existed. In his opinion, however, there clearly was evidence that ought to have been submitted to the jury, and there ought, he thought, to be a new trial in spite of the fact that plaintiffs took some proceedings under the Workmen's Compensation Act before the Deputy Judge.

Mr. Justice WELLS and Mr. Justice CHANNELL concurred, and a new trial was ordered, the defendants to have the costs of the appeals and cross appeal, and the costs of the previous trials to abide the result of the new trial.

Mr. MOYSES said the plaintiffs had been unfortunate with their ventures at the Westminster County Court; would their Lordships remove the trial to some other Court?

The LORD CHIEF JUSTICE: Oh no; I think not.

LIABILITY FOR CONTINUOUS SUPPLY.

ON Tuesday, Judge Austin, in the Bristol County Court, heard and decided a rather curious action brought by a firm of vinegar manufacturers against the Bristol Corporation as owners of the electrical works. The plaintiff was Mrs. Adelaide Powell, who traded as A. J. H. Hutchings & Co., in Bristol, and who formerly employed steam power to operate the plant which had to keep in constant motion the fermenting wort. In May, 1901, the firm decided to adopt electricity, the object being to dispense with the necessity of an attendant to continually look after this machinery. They obtained two motors, and agreed with the Electrical Committee to allow the officers of that Committee at all reasonable times to come on their premises to test the apparatus. On several occasions the current was interrupted after notice, but on October 25th, 1902, the brewer having received no intimation of a stoppage left the premises at 11 o'clock at night, leaving the acetifier at work. Later the current was cut off, the vinegar-making process interrupted, and damage done amounting to £5 4s. 2d. This was the amount claimed.

Mr. G. F. POWELL, on behalf of the plaintiff, stated that when agreeing with the Electrical Committee, it was pointed out that the object of introducing electricity was to save a man attending all night at the brewery.

For the defence it was submitted that there was no obligation to maintain a continuous supply of electricity, but Judge AUSTIN, after referring to the contract, said that every reasonable step should be taken to give a continuous supply, and reasonable notice of stoppage should be given.

Mr. FARADAY PROCTOR, electrical engineer, explained that the current was cut off at 7.30 on Sunday morning, and a man was sent round to the premises on the cable to give notice. There was no obligation to give notice, but it was done to prevent inconvenience. He considered that such motors as those of plaintiff should have a constant attendant; every motor should have a constant attendant.

Mr. H. H. COUSINS, from the office of the electrical engineer, stated that he had no recollection of being told that the motor must be one which could go unattended, and Mr. POLAND, station superintendent, gave similar evidence.

Mr. WEATHERLY, the counsel for the Corporation, contended that there was no legal power to promise a continuous supply and no legal obligation to give notice of stoppage, although, as a matter of courtesy, it was done.

Mr. COCHRANE, for the plaintiff, argued that notice should have been given. The stoppage was not the result of an accident, and the Corporation was not entitled to the immunity for which they provided in the contract. His Honour said it seemed to him the Corporation undertook to give a reasonably continuous supply, having regard to all the circumstances of the case. He did not say they undertook the obligation of always keeping the current going, but they must do so, having regard to the necessities of the business. What was the result? The Corporation wanted to add another customer, and on this morning stopped the supply and cut the cable. They should have given notice before doing this. There was, he considered, a breach of contract. It seemed clear that the officials of the electrical department knew that the motors were used for vinegar brewing, and that they were to go unattended. Judgment would be given for the amount claimed with costs.

NOTES.

Naval Electricians.—The *Hampshire Telegraph* says: "Another official recognition of the importance of mechanical ratings in the Royal Navy is to be found in an Admiralty order, just issued, relative to naval electricians. When mechanics were entered as electricians two years ago, it was generally understood that they would remain in that grade. Now, however, the Admiralty have decided to allow them to attain the rank of chief electrician—a position similar to that of chief engine-room artificer. Before being entitled to promotion to this rank, it will be necessary for men to have served at least eight years as electricians. They must also pass a satisfactory examination, both theoretical and practical. On joining the Navy, electricians receive pay at the rate of 5s. 6d. a day, and on promotion to chief electrician they will receive 7s. a day, with an additional 6d. a day after serving for six years."

The Electricals.—The committee have arranged a smoking concert for Tuesday, January 20th next, at the Blue Posts, Newman Street, at 7.30 p.m. Members who have not secured tickets, should apply to the hon. secretary, Mr. Oldham, at once, as only very few remain for disposal.

The Diesel Engine.—Mr. Wilkinson, of Harrogate, recently read a paper on the Diesel engine before the Scientific Society of Glasgow Technical College, giving many interesting particulars relating thereto. Though originally Diesel aimed at a Carnot cycle of operations, he did not realise this, and the Diesel engine really differs very little from any other engine; there is probably nothing of any real moment in the whole question of cycles in the practical engine. But what difference there is is important, for it consists in avoiding compression of a combustible mixture, and there is no temperature limit to compression. Consequently in a Diesel engine, compression is carried to a red heat, and then the fuel is forced into this heated air and burned. The pump which maintains the air pressure in the three reservoirs used for forcing the fuel, and for starting the engine, draws from the cylinder itself, and thus gets the benefit of a double-stage compression which economises power and reduces the size of the compressing pump. The engine is started by the store of compressed air, and the makers usually send out these reservoirs ready charged to start a new engine. Already building up to 250 H.P., the Diesel Co. will quote up to 1,000 H.P. It will use as fuel light oils of benzine type of a sp. gr. below 0·79; or petroleum lamp oils of sp. gr. 0·79 to 0·85; or the solar oils of 0·85 gravity, such as are termed fuel oils in America, or crude Russian or other oils of heavy type more or less coloured and viscid, as well as astatki or mazout of 0·905 gravity, and the products of coal distillation. Alcohol can be used if cheap enough, and so also can the animal and vegetable oils. With oil at 40s. per ton, or 2d. per gallon, a consumption of 0·47 lb. per B.H.P.-hour works out at 0·10d. per B.H.P.-hour. We hope to have more to say on the Diesel engine, which ought to receive the attention of the makers of hydrogenous power gases if they hope for any success with this gas in engines.

Private Bills. — Memorials have been deposited in the Private Bill Office of the House of Commons in respect of the following Bills, having provisions of an electrical character, alleging non-compliance with standing orders:—Chatham and District Light Railways Bill, by the Corporation of Rochester; Mid-Yorkshire Tramways, by the Corporation of Keighley; Hove, Worthing and District Tramways, by the Corporation of Hove and Worthing; Rochester, Chatham, Gravesend and Maidstone Tramways, by the Corporation of Rochester; the London and Brighton Electric Express, by the London, Brighton and South Coast Railway and the South-Eastern Railway Co.; the Beckenham Urban District Council Bill, by the London County Council; the Pontypridd Urban District Council, by the Taff Vale Railway Co.; the Erith Tramways and Improvements, by the London County Council.

Electrical Automobile Fire Service Vehicles in Berlin.—Following the example set by Paris, experiments are now being tried in Berlin with an electrical motor fire-service vehicle to carry firemen to the scene of the outbreak immediately on receipt of a "call." The vehicle, which carries a reel of hose, ladders, &c., weighs, when loaded, 1,000 kg. (2,200 lbs.). It is driven by a 4-H.P. electric motor, running at a speed of 1,500 revolutions per minute and transmitting its power to the rear axle through a double reduction gear. The electrical energy is furnished by a battery of accumulators weighing 600 kg. (11 cwt. 88 lbs.); a speed of 9½ miles per hour can be attained, the motor taking 45 amperes at a pressures of 85 volts. A second, more powerful, automobile is also being tried by the Berlin Brigade authorities, capable of attaining a speed on the level of 12½ miles per hour. It is driven by two electric motors, each of which is rated at 9 H.P., but can, on occasion, develop 12 H.P. without fear of damage. The battery, which weighs 1,500 kg. (3,300 lbs.), has a capacity of 14 KW.-hours, and will propel the car for an hour at the speed named above. The vehicle, with its electric motors, weighs 4 tons; complete with battery, firemen, hose, ladders, &c., its weight totals 7 tons. After a lengthy trial the coefficient of traction has been found to be 30 kg. per metrical ton. The cost of the electrical energy to run the car a distance of 12½ miles is estimated at 2 marks 10 pfennig (say, 2s.). The cost of a car like the second one referred to is stated to be £600; the annual outgoings, for 200 turnouts, averaging a 5-kilometre (3½ miles) run each, is put down at £125, this including 5 per cent. interest on the first cost, and 5 per cent. for depreciation and renewal. The average cost per kilometre works out at 2½ marks (a little under 2s. 6d.), which is stated to be less than that of animal traction.

The Fire Prevention Congress.—We have received from Mr. Ellis Marsland, the hon. secretary of the International Fire Prevention Congress, which is to be held in London in July next, a programme of the events which have been arranged, together with an explanation of the objects and arrangements of the Congress. Copies of this programme can be obtained by all interested by applying to Mr. Marsland at 1, Waterloo Place, Pall Mall, W.

Tramways and Light Railways Association.—The current circular of this Association records the death of Mons. J. Röhl, vice-president of the Union Internationale. It also announces the acceptance of the invitation to Mr. L. A. Atherley Jones of the presidential chair of the Association for the year 1903. It is stated that a proposal has been made to contribute towards the cost of such researches on electrolysis as the National Physical Laboratory may institute. The circular also contains a copy of the model form of tramway returns which has been submitted to the Board of Trade by the Association's secretary.

Protest against Municipal Trading.—At a meeting of owners and ratepayers of Sheffield on January 8th, a strong protest was made on behalf of the electrical traders of the city against Clause 26 of the Corporation Bill. The first speaker stated that he was not satisfied that the Corporation had not carried on the small fittings department attached to the electricity undertaking at a considerable loss. The tradesmen of the city had cut their prices down to the lowest margin, but could not get work because of the competition of the Corporation. This was not fair trading. The Corporation was sheltered behind a monopoly to which protection was a mere baby, and the tradesmen had to contend with disadvantages which would make it impossible for them to conduct their businesses successfully. He urged the Council before entering into this big fight—and a big fight the tradesmen were determined to make it, if the Corporation insisted—to hesitate before inflicting this permanent injury upon any section of their ratepayers and citizens. In reply, Alderman Styring said it was intended under the clause to establish a wiring and fittings department. They had carried on the department taken over from the company, and did not intend to extend it. The main object of the section was to empower the Corporation to purchase motors to let out on hire to manufacturers, thus relieving them from the necessity of having their own motors, and increasing the consumption of current. About 40 persons left the meeting as a protest against the clause.

The Reason Manufacturing Co., Ltd., v. Ernest F. Moy, Ltd.—The hearing of this case was heard in the Court of Appeal, composed of the Master of the Rolls and Lords Justices Romer and Cozens-Hardy, on Wednesday, on the appeal of the defendants from the judgment of Mr. Justice Byrne, in the Chancery Division, dated April 23rd last. The action was brought by the plaintiffs to restrain the alleged infringement by the defendants of a patent owned by the plaintiffs, which had relation to fuse boxes for electricity supply mains. The object of the invention was to avoid the dangers and inconvenience of "short circuiting." The patent was for the construction and arrangement of electric fuse boxes which automatically prevented access being obtained to more than one fuse at a time. The boxes were made with a shallow body and a deep lid, and were placed back to back, and so close together, that when one was opened, it prevented the other from being opened. The defendants admitted infringement of the plaintiffs' patent, but pleaded that the letters patent were invalid for want of subject matter. Mr. Justice Byrne held that there was subject matter in the invention, and granted the injunction asked for. Hence the present appeal of the defendants. Mr. Thos. Terrell, K.C. and Mr. Walter appeared for the appellants, and Mr. Fletcher Moulton, K.C. and Mr. Gray for the respondents. In the result their Lordships held that there was no subject matter in the patent, and allowed the appeal with costs.

The National Electrical Contractors' Association.—The Northern Section of this Association held an interesting gathering on January 10th, it being the annual meeting, at which the retiring President, Mr. H. Bland, delivered an address on the work of the Section and the various ways in which members derived benefit from it. Forty firms had joined during the year. Good work had also been done in the registration of workmen so as to secure better work. The issue of new Regulations by the Institution of Electrical Engineers would considerably improve their position in their desire to have only good work done. Their interests were identical with those of the manufacturers and operatives so far as the aiming at improvement was concerned, and he was pleased to inform them that a Joint Committee was sitting in London, having for its object combined action for the general good of the trade. The Northern Section had under consideration the better education of apprentices and workmen technically, and he hoped all local associations would to this end support and avail themselves to the fullest extent of whatever powers were granted in the new Education Act. He stated that the contractors in the North had little to complain of, unless it were the somewhat unfair tactics of some American manufacturers, which were hardly fair from a trade point of view to British manufacturers. He urged members to complete their organisations locally, and to use the Association crest which would soon become known to the public as a guarantee of ability and good work. He paid a hearty tribute to the work done by Mr. Cross as hon. secretary. In conclusion, he was sure that the coming year would be a busy one in the electrical trade, if only municipal councils and similar bodies did not throttle the industry by unfair competition. It was their duty to oppose Parliamentary Bills containing powers which threatened such issues. On 9th inst. Mr. Bland entertained the members at dinner, and in the course of a speech Mr. Rawlings said that the London Association was making rapid progress, it having already over 100 members in London alone. The new president of the Northern Section is Mr. E. C. Wallis, of Leeds.

Metropolitan—L.C.C. Arbitration.—On 7th inst. an arbitration inquiry involving a claim of £322,000 was commenced between the Metropolitan Electric Supply Co. and the L.C.C., Sir J. Wolfe Barry acting as umpire. Sir Fredk. Bramwell is arbitrator for the company, and Mr. Andrew Young for the Council. The proceedings arise out of the compulsory acquisition of the company's electric generating station in Sardinia Street by the L.C.C., to make room for the new Avenue from the Strand to Holborn. The Council will provide a site for a new station near the old site, and the question at issue is the amount required to cover the cost of new plant. The proceedings were resumed on the following day.

Electrolytic Meters.—The following letter came to hand too late for our "Correspondence" columns:—

"Bastians, Ltd., kindly undertake to instruct us. They tell us that the electrolytic principle is accurate to 1 per cent. We were under the impression ourselves that the accuracy of the measure was absolute. Whether electrolytic meters, in practice, record and can be read with similar accuracy is quite another question. We think we are familiar with all the facts with which they desire to acquaint us, but we find in addition statements not in this category.

"We did not specially refer to the Bastian meter, nor did we say that all electrolytic meters had all the faults we mentioned, nor did we presume to think that our catalogue of their defects was exhaustive; the fact being that all these meters have some of the faults mentioned by us, some have all, and some more than all.

"For instance—and we mention this here because it happens to apply to the Bastian meter—we did not refer to the destruction of record that frequently takes place. The meter man comes round; he finds the water column nearly exhausted; he makes a note in his book, and proceeds to fill up. At the end of the quarter there is no record of this proceeding except the note in the book. The meter man may have accurate habits, or he may not. His note may be reliable; on the other hand, it may not. But the point is that the consumer has, under the circumstances, no means of checking his bill.

"Nothing that Bastians, Ltd., tell us about electrolytic meters is new to us—at least, nothing that is true. And they proceed to tell us much that is new and not true concerning our own. We content ourselves, however, with simply repeating our former statement which they find so absurd—viz., that our meters do not consume any current and do not cause a fall in pressure of more than half a volt; with this addition, that in our smallest size, which: perhaps, is specially comparable with the electrolytic, while still no current is consumed, the fall in pressure is less than one-fiftieth of a volt. We do not wonder that, to minds habituated to the fall of volts caused by electrolytic meters, this seems incredible. But should they not explore a region before they attempt to describe it?

"After reading the letter of Bastians, Ltd., we are not inclined to modify our former opinion, viz., that electrolytic meters are at present on their trial, and that the most that can be said for them is, as we said before, that they present 'many interesting possibilities.' And, in addition, we would now call attention to the very great objection pointed out above, viz., that the consumer, if he takes more current than the very small amount provided for by the water in the tube, is unable to check the meter readings, and consequently, in the event of the account being disputed, the method of testing the meter provided by the Electric Lighting Act cannot be followed.

"*For* CHAMBERLAIN & HOOKHAM, LTD.,
"JOSHUA BROWN, *Secretary.*"

Criticism of Admiralty Boilers.—A criticism of the cylindrical boilers for six new cruisers of the *Devonshire* class is put forward by Mr. Halliday in *Cassier's Magazine*. It is an unfavourable criticism. The new boilers, in place of a length of 10 ft. 6 in., are only 9 ft. long, the tubes being 6 ft. 3 in. in place of 9 ft. 9 in., and it is feared that from the way in which the bridge is placed, right in the combustion chamber, there will be trouble when forced draught is employed and the tubes will be loosened in their plates. There are also three furnaces of 36 in. in place of two of 44 in., a change that will not be favourable to combustion, and generally the new design seriously reduces the flame-space and cuts down the heating surface. It also reduces the steam space from the usual 0·47 cb. ft. per H.P. to 0·32. The ratio of grate to heating surface is 1 to 33½ as against 1 : 45. The Admiralty thus appear to have gone back to that insufficiency of design which caused the trouble in the Navy when forced draught was first applied to cylinder boilers, and it is to be feared trouble will again appear, and people will ask why the cylinder boilers that have worked nearly 30 years in the *Britannic* will not work in the Navy. These cylinder boilers are perhaps thought to be sufficient, as they are to be used at easy speeds, the main complement of boilers in the ratio 4 to 1 being of the water-tube type, to be worked when the enemy heaves in sight. The new pressure is to be 200 lbs., the *Hyacinth* having shown no advantage from her high-pressure engines. It appears that lightness of machinery in the cruisers *Hyacinth* and *Minerva*, viz., 378 and 365 tons as compared with 709 tons in the merchant steamer *Saxonia* of equal power, is gained at a sacrifice of ¾ lb. of coal per I.H.P.-hour. Thus the saving in weight is lost in 4½ days extra coal consumed at 9,000 H.P., which shows how absolutely false an economy it may be to save weight at the expense of fuel; this is the vital element after all, for in war times the stores of fuel will be often unreplenished and the less that can be used the better it will be. Ships must not be designed simply to fight a foe only 70 miles away. We are far less likely to fight with France than certain other people.

The Johannesburg Scheme.—The consulting engineers to the Town Council recently submitted their report on a system of light, power and tramways for Johannesburg. The report is an exhaustive one, and deals with the existing provision for light and power. In re-organising the plant at the municipal generating station, the engineers recommend the Council to entirely discard the present apparatus, which, on the ground of smallness alone, is quite unsuitable, apart from any questions of the type of dynamos.

Series Vapour Engines.—Wanted a fluid with the properties of naphtha, but uninflammable. Such appears to be the one thing needful to render possible the series vapour engine, as expounded by Prof. Thurston in the *Journal of the Franklin Institute*. The fluids available for binary fluid engines include ammonia, chloroform, sulphur dioxide, ether, bisulphide of carbon, and other liquids of low boiling point, including a long series of petroleum products for use in even a multiple series engine. All the fluids are costly, and many are dangerous apart from their combustibility; as, for example, ammonia and chloroform, which are not pleasing articles when let loose in any volume. Mere cost is nothing if there is but little wastage. A gas engine, which rejects its working fluid at a high temperature, appears peculiarly fitted to be the primary of a series system, both its cooling jacket and its exhaust affording a copious supply of heat to vaporise a second fluid, or even a triple series, with steam to follow the gas and petroleum and ether to follow. To-day leakages both outwards of the fluids and inwards of air into vacuum can be better guarded against than when Rankine wrote; still, except so far as Yarrow appears to have been very successful with the naphtha launch, not very much seems to have been done with binary engines. At first glance, the use of a second fluid boiling at a low temperature is very seductive, but though such fluids may have a high pressure with a low temperature and a low specific heat, their vapour densities are very great, and this is a fact which goes a long way to neutralise their other qualities.

Personal.—Mr. Frank Hedley has been appointed superintendent of the New York underground railway. He has been acting for Mr. Yerkes as superintendent of lines at Chicago.

Lectures.—Before the Institution of Civil Engineers of Ireland last week, Mr. Mark Ruddle read a paper on "Electrical Transmission and Transformation of Energy."

Prof. Hudson Beare, Edinburgh University, read a paper on "Recent Developments in the Gas Engine and the Utilisation of Blast Furnace Gases" before the Glasgow Scientific Society on Saturday evening last. During the course of a very interesting lecture, the author showed views of the Mond producer and the Cockerill engine. A discussion followed, in which Prof. Watkinson, Mr. J. F. Rowan and Bailie Burt took part.

I.E.E. Students and the Building Fund.—The secretary of the students' section of the Institution of Electrical Engineers has sent a circular round to the 500 members of that department inviting them to subscribe to the Building Fund. It is said in the course of the invitation that there are many members and associates who are giving to the fund, but who may never live to see the long-desired premises erected. As students are presumed to stand a better chance, they are reminded of their obligations in the matter, and we hope that they will take the hint and subscribe to the full extent of their ability.

The Pacific Cable.—A Parliamentary return just issued shows that the expenditure under the Pacific Cable Act for the period ended March 31st last was £1,044,701, the balance of authorised issue in excess of expenditure being £16,233 18s. 4d. The payments include: Cable contract, £1,009,285; instruments, £10,119; ship contract, £15,975; and engineers' fees and expenses, £9,135.

The Stanley Show.—At this show, which opens to-day at the Crystal Palace, and remains open until 24th inst., the Electric Carriage Manufacturing Co., of Victoria Street, S.W., has a neat electric coupé on exhibition.

Appointments Vacant.—An engineering clerk of works for Stretford; an assistant electrical engineer for Bray at £65; Barnes U.D.C. requires a shift engineer at £100; general clerk at Hornsey E.L. Works at £100.

THE CENTRAL STATION ENGINEER.

MR. HOOLEY, of Fleetwood, has been appointed junior engineer at the Crewe Borough Electricity Works.

Gillingham (Kent) U.D.C. has retained the services of Mr. A. D. CHALMERS, the resident engineer of the electric lighting company, as resident electrical engineer.

Mr. J. ELLIS, Mickleneld, has been appointed electrical engineer to the Morley Corporation at a salary of £200 per annum.

The Electricity Committee of Carlisle T.C. has increased the salary of Mr. C. D. BURNET, electrical engineer, from £250 to £350 per annum, the advance to date from March 25th next.

The St. Helens T.C. on January 7th ratified the appointment of Mr. E. M. HOLLINGSWORTH as borough electrical engineer, at a commencing salary of £350 a year. This salary is to include the superintendence of the refuse destructor.

The Burnley T.C. on January 7th adopted the recommendation of the Electricity Committee, that the salary of the electrical engineer (Mr. BIRKETT) should be increased from £300 to £350 per year, with a further increment of £50 at the end of six months. Mr. Birkett has also been voted a gratuity of £200 for special services rendered in connection with the electrification of the tramways.

Mr. J. Hayward Home is resigning the position of chief assistant with the Folkestone Electricity Supply Co., Ltd., in order to accept the post of resident engineer at Berwick-on-Tweed with Messrs. Edmundson's Electricity Supply Corporation. His new duties commence next month.

The Hornsey D.C. on 12th inst., resolved that Mr. Norman Staniland be appointed resident electrical engineer, and that the appointment and increase of salary to £300 a year date from February 1st.

NEW COMPANIES REGISTERED.

Allan's Metal Syndicate of America, Ltd.—This company was registered on December 11th, with a capital of £100 in £1 shares, to acquire from Sherard Cowper-Coles & Co., Ltd., and C. E. Allan, the benefit of certain existing inventions relating to the electro-deposition of metals, to turn the same to account and to carry on the business of miners, metallurgists, ore treaters, workers and merchants, &c. The first subscribers (each with one share) are: R. Steele, 6, Gracechurch Street, E.C., naval architect; H. A. Hankey, 4, Grafton Street, W., company manager; E. G. Woodridge, 53, Thornton Avenue, Streatham Hill, S.W., secretary; W. J. H. Mole, Bampton Lodge, Lausanne Road, S.E., gentleman; A. Pitt, 34, Clement's Lane, E.C., clerk; H. G. Carvell, 129, Queen's Road, Dalston, N.W., clerk; and C. W. Barrett, 4, Hazelborne Road, Balham Rise, S.W., clerk. No initial public issue. The first directors are C. E. Allan and R. Steele; qualification one share; remuneration as fixed by the company.

Automatic Telephone Co. (1903), Ltd. (76,025).—This company was registered on January 10th, with a capital of £100,000 in 2s. 6d. shares, to acquire the patents, rights, privileges and advantages now held by or in trust for the Automatic Telephone Co., Ltd., and to carry on the business of a telephone, telegraph and electric light, heat and power supply company in all or any of its branches. The first subscribers (each with one share) are:—H. G. Sworn, M.D., 5, Highbury Crescent, N.; S. W. Smith, Braidwood Place, 32, Beulah Road, Tunbridge Wells, gentleman; H. Cameron, 19, Park Road, Norbiton, gentleman; H. G. Marsden, 22, Dennington Park Road, W. Hampstead, N.W., traveller; M. Margowski, 13-14, Abchurch Lane, E.C., merchant; E. G. Festing, Lt., R.N., 43, Limes Grove, Lewisham, S.E.; and R. S. Marsden, 22, Dennington Park Road, N.W., secretary. No initial public issue. The number of directors is not to be less than two nor more than five; the first are to be appointed by the subscribers. The preference shareholders may at any time nominate two directors; qualification (except for first or "nominee" directors) £500; remuneration, 100 guineas each per annum and 25 guineas extra for the chairman, with an increase according to profits. Registered office, 13-14, Abchurch Lane, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Anglo-Portuguese Telephone Co., Ltd. (24,545).—Issue on December 29th of £7,000 second debenture bonds, part of a series created March 21st, 1890, to secure £40,000 charged on the company's property, present and future, subject to £10,000 first debentures. No trustees. Total amount previously issued of same series, £3,000.

Lewisham and District Electric Supply Co., Ltd. (66,420).—A mortgage or charge on the company's undertaking and property, dated July 8th, 1902, to secure an unspecified amount (stamped on December 13th, to cover £2,000 in addition to £6,000 previously obtained), has been registered. Holders: Blackheath and Greenwich District Electric Light Co., Ltd., 37, Tranquil Vale, Blackheath.

Electric Light and Power Co. of Japan, Ltd. (60,811).—The annual return of this company was filed on December 1st, when seven shares were taken up out of a nominal capital of £3,000 in £1 shares. No calls have been made. Mortgages and charges, nil.

Marconi International Marine Communication Co., Ltd. (65,759).—The annual return of this company was filed on December 23rd, when 204,056 shares were taken up out of a nominal capital of £350,000 in £1 shares. 12s. 6d. has been called up on each of 99,056 shares, and £61,874 17s. 6d. has been paid, leaving £27 2s. 6d. in arrears. 105,000 shares considered as fully paid. Mortgages and charges, nil.

Brisbane Electric Tramways Investment Co., Ltd. (67,353).—An acknowledgment of indebtedness, dated December 31st, 1902, creating £25,000 further debenture stock, making with £400,000 already created a total of £425,000, and being supplemental to a trust deed dated November 21st, 1900, has been registered. Property charged: £749,465 fully paid shares on the Brisbane Tramways Co., Ltd. Trustees: Sir H. S. King, 65, Cornhill, E.C., and E. D. Vaisey, 39, Threadneedle Street, E.C.

Incandescent Electric Lamp Co., Ltd. (39,316).—Issue on January 2nd, of £10,000 debentures, created December 17th, 1902, charged on the company's undertaking and property, present and future. No trustees.

Uxbridge and District Electric Supply Co., Ltd. (62,706).—Issue on December 30th, of £500 debentures, part of a series created July, 18th, 1901, to secure £20,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £17,000.

SUPPLY STATION ACCOUNTS.

Edinburgh Corporation Electricity Accounts.

The analysis given below of the accounts of the Edinburgh electricity supply stations indicate very clearly the effect of the high price of coal in 1900. In consequence of this there was an actual loss on the working of the department for the first of the two years now considered. The rapid strides made by the Corporation supply in the Scottish capital are shown by the collected figures for the past five years.

Progress Table.

Year.	Capital.	Revenue.	Expenditure.	Profit.	Net result.	Units sold
1897	£287,466	£38,049	£17,402	£20,647	£5,024	2,894,437
1898	£395,357	£48,238	£24,508	£23,730	£5,886	4,174,541
1899	£595,655	£63,659	£32,687	£30,972	£3,674	5,551,728
1900	£707,036	£79,376	£43,588	£35,788	−£2,690	6,708,011
1901	£765,612	£90,960	£38,906	£52,054	£10,295	7,759,223

The capital expenditure now exceeds three-quarters of a million, but of this only £58,000 odd were spent in 1901. The low rates of charge have led to a very general use of electrical energy, and the results are a strong argument in favour of those who contend that the sliding scale is not an *essential* element in the business o electricity supply.

General Statement.

	1900.	1901.	Inc.
Total capital expenditure ...	£707,036	£765,612	£58,576
Number of units sold	6,708,011	7,759,223	1,051,212
Number of lamps connected ...	378,580	—	—
Maximum load in KW.	5,000	—	—
Gross revenue	£79,376	£90,960	£11,584
Gross expenditure...	£43,588	£38,906	−£4,682
Gross profit	£35,788	£52,054	£16,266
Average price per unit sold ...	2·83d.	2·80d.	−·03d.

In 1900 the ratio of units sold for private and public lighting was 5,481,497 and 1,226,514 respectively. In that year 846 10 and 15-ampere arc lamps were supplied, the capacity of plant was 8,137 KW., and the prices charged, for lighting 3½d. per unit, with discounts, and 1½d. net for power. In 1901 5,123,133 units were sold for private lighting, 1,325,481 for motive power, and 1,310,609 for public arcs, the prices charged remaining unaltered, and £13 annually being the rate for the street arc lamps.

Revenue Statement.

	1900. Gross.	1900. Per unit.	1901. Gross.	1901. Per unit.	Inc.
Sale of energy	£79,108	2·83d.	£90,699	2·80d.	−·03d.
Meter rents.	23	·00d.	32	·00d.	·00d.
Sale of lamps, &c.	—	—	—	—	—
Sundry fees, rent received, &c.	245	·01d.	229	·01d.	·00d.
Gross revenue ...	£79,376	2·84d.	£90,960	2·81d.	−·03d.

The deficit on the balance-sheet for 1900 was caused by the high price of coal (between 40 and 50 per cent. above the previous year), the large increase in financial charges on capital expended on the M'Donald Road station, and the large drop in energy sold due to the death of Queen Victoria. In 1901 the coal bill was £6,617 less than in 1900, which more than covers the increase in expenditure of £4,682.

Cost of Production.

	1900. Gross.	1900. Per unit.	1901. Gross.	1901. Per unit.	Inc.
Coal	£17,659	·63d.	£11,042	·34d.	−·29d.
Oil, waste, water and engine room stores and carbons.	2,291	·08d.	2,344	·07d.	−·01d.
Salaries, allowances, and wages incurred in generation and distribution and attending street lamps.	7,986	·29d.	7,656	·24d.	−·05d.
Repairs and maintenance of buildings, engines, boilers, dynamos, and renewals to public lamps.	5,451	·20d.	5,792	·18d.	−·02d.
Works costs ...	£33,387	1·20d.	£26,834	·83d.	−·37d.
Rent, rates and taxes ..	5,307	·19d.	5,655	·17d.	−·02d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	2,626	·09d.	2,499	·08d.	−·01d.
General establishment charges, stationery and printing, law charges and insurance.	1,764	·06d.	2,831	·09d.	+·03d.
Other expenses, repairs to property, loan charges, &c.	504	·02d.	1,087	·03	+·01d.
Total costs ...	£43,588	1·56d.	£38,906	1·20d.	−·36d.

With an increase in revenue of £11,584, and a decrease in costs of £4,682, the gross profit rose by £16,266. Of this £3,281 was taken by augmented financial charges, leaving £12,985 to turn the loss in 1900 into a profit of £10,295. The deficit of £2,690 brought forward was paid for out of this sum, and the balance of £7,606 was carried forward to the current year's accounts.

Profit Statement.

	1900.	1901.
Interest on loans and overdraft, &c.	£17,681	£18,274
Sinking fund for repayments	20,797	23,485
Net profit carried forward	−2,690	10,295
Gross profit	£35,788	£52,054

CITY NOTES.

Western Union Telegraph Co.

With the last annual report of the Western Union Telegraph Co. is presented, says the *Financial Times*, a number of statistics showing the enormous progress made by the undertaking during the last 36 years. "This advance is sufficiently indicated by the fact that, as against the 113,000 miles of cable, wire and pole and the 2,200 offices in 1866, the company now possesses 23,600 of the latter and 1,226,000 miles of the former. Compared with figures like these even the 44,000 miles of cable of our biggest telegraph concern, the Eastern, seem very small and insignificant. In point of fact, the Western Union added alone last year nearly one and a-half times the Eastern's total mileage. A system so vast necessarily means a tremendous amount of business, and nearly 69,400,000 messages were transmitted during the last financial year, without counting the messages sent by brokers, &c., over leased lines. The average toll per message for the last 17 years has been about 30 cents, of which from 5 to 6 cents is profit. The company's net revenue works out at about 1½ million sterling."

Stock Exchange Notices.—Applications have been made to the Committee to appoint a special settling day in and to grant a quotation to—British Electric Traction Co., Ltd.—Further issue of 75,000 6 per cent. cumulative preference shares of £10 each (issued at £2 premium), £5 paid (of which £3 is capital and £2 premium). The Committee has further been asked to allow the following to be quoted in the Official List:—Callender's Cable and Construction Co., Ltd.—Further issue of £110,000 4½ per cent. first mortgage debenture stock (redeemable). The Committee has appointed special settling days as under:—Wednesday, January 21st. Bath Electric Tramways, Ltd.—59,394 5 per cent. cumulative preference shares of £1 each, 12s. 6d. paid, Nos. 1 to 59,394; and 75,606 preferred ordinary shares of £1 each, 12s. 6d. paid, Nos. 75,001 to 150,606; and has also ordered the undermentioned to be quoted in the Official List:—Willans & Robinson, Ltd.—£135,000 4 per cent. first mortgage debenture stock, in lieu of the scrip, and to be added to the amount now quoted.

City and South London Railway Co.—The accounts for the half-year ended December 31st, 1902, show a balance, after providing for the debenture stock interest, the payment of the dividend on the preference stocks, and transfer to renewal fund of £2,000, sufficient to allow payment of a dividend on the consolidated ordinary stock for the half-year, at the rate of 3½ per cent. per annum, carrying forward a balance of £1,269. The dividend for the corresponding period last year was at the rate of 2½ per cent. per annum, carrying forward a balanae of £1,424.

Issue.—The *Westminster Gazette* learns that Speyer Brothers will on Saturday next issue £2,000,000 of Great Northern, Piccadilly, and Brompton Railway shares at par. Four per cent. dividends on these shares will be guaranteed by the Underground Electric Railways Co. of London, Ltd., which has a capital of £5,000,000, of which £2,500,000 is paid up.

Direct U.S. Cable Co.—Interim dividend, 3s. per share (at the rate of 3 per cent. per annum) for the quarter ending December 31st, 1902. This is after setting aside £10,000 to reserve fund, and carrying forward about £4,780. The tranfer books will be closed from January 13th to January 27th.

Chelsea Electricity Supply Co.—A meeting of the shareholders of this company was held on Wednesday afternoon at Winchester House. A representative of the Electrical Review, who attended to report the proceedings, was informed that the meeting was strictly private.

Globe Telegraph and Trust Co.—The directors have declared an interim dividend of 1s. 9d. per share on the ordinary shares.

Typewriting Telegraph Corporation.—A meeting of this company was held in London yesterday.

STOCKS AND SHARES.

Wednesday Evening.

Even if the first settlement of the year has proved somewhat disappointing in regard to the volume of business brought to the Stock Exchange, events seem to be shaping themselves more comfortably to a revival later on. When once the Transvaal Loan is issued—we are sick of writing and hearing about the thing—there will be no more Government borrowing connected, at all events, with the Boer War, and that in itself should bring relief to markets surfeited with gilt-edged investment securities. Moreover, it is generally surmised that the reduction of interest on Consols will have the effect of causing old-fashioned holders to realise, first, the loss of income entailed, and secondly, the stock which produces it. These are so many points in favour of such departments as those wherein electrical descriptions move, and whether it be in intelligent anticipation or not, the fact remains that a line of good electrical supply Debenture stock has only to present an appearance in the market for it to be eagerly snapped up.

Foremost amongst the Home Railway companies to declare its dividend is the City and South London Railway, which last Tuesday announced a distribution at the rate of 3½ per cent. per annum. This compares with 2½ per cent. paid a year ago, and is the best in the record of the company. It makes 3½ per cent. for the whole year 1902, so that at the current price of 76 the stock looks decidedly cheap. Of course, the favourable character of the last six months for short-distance traffic has to be borne in mind, but after making all allowances the result achieved is excellent, and the proprietors in this pioneer electric line deserve congratulation upon the dividend for the year. It forms a very useful answer to the line's critics in their complaints about over-extension, for all the profits could hardly have been made had it not been for the Islington part of the undertaking. The Ordinary stock has risen to 77 on the announcement.

Central London stocks remain about the same, the Deferred alone advancing a point. Waterloo and City has not materially altered its position. Great Northern and City Preferred "A" shares are 8, but Mersey Railway securities are moving up. The Ordinary has advanced to 15, and the 5 per cent. Perpetual Preference to 19; in both cases the nominal amount is £100 stock. What buying there is seems to be inspired by the idea that electrification will revolutionise the earnings of the company, but only a confirmed gambler would dabble in such counters as the stocks of the Mersey Railway. Both Metropolitan Consolidated and Metropolitan District have experienced a sharp jump during the week.

Chelsea Electric Supply shares keep their price at 5½, undisturbed by the meeting held on Wednesday to confer as to what should be done by way of getting rid of the founders' shares in the company. Of these there are at present 500, one moiety having been issued as fully paid to the contractors, and the other half to the original subscribers. Up to the present no dividend has ever been paid on these founders' shares, but the latter have the right to one-third of any surplus profits arising in the year after 6 per cent. is paid to the Ordinary proprietors. It is just as well that these founders' shares should be extinguished—in fact, they ought to have been long ago, but it would seem as though they were at last to be exchanged for a security which shall give satisfaction to both parties.

So long as the Metropolitan Electric award remained in suspense, the dealers in the market declined to make any price whatever as the day drew near for its announcement. Some feeling has been aroused over the way in which the award was to be published, the company, we understand, acknowledging its readiness to communicate the news to the Stock Exchange immediately it became known, but impeded by the fact that it was the place of the Borough of Marylebone to take up the award. Consequently the company lay at the mercy of the borough in regard to the moment for making the declaration to the Stock Exchange and its shareholders.

Globe Telegraph and Trust shares are to receive their usual interim dividends, and the price of the Preference shares keeps about the same as before, while the Ordinary are a fraction easier. The Eastern group in the telegraph market remains steady, there being very little doing in the stocks. Nor do the Anglo-American trio move, despite the near approach of the time when the anxiously-awaited dividend announcements shall be made which are to determine not only whether the Deferred stock is to have anything at all, but whether the Preferred Ordinary is to get its full 6 per cent. for the year 1902.

National Telephone stocks display a slight indecision as to their future course, but the Preferred is a point harder, and the first Preference shares have risen ½, although, curiously enough, the second Preference shed the same amount. Probably an explanation is to be found in the suggestion that holders of the second Preference are selling with a view to an exchange into the first Preference, there being so small a difference in the prices of the shares.

Amongst the out-of-the-way descriptions, a further rise has lifted River Plate Lighting and Traction Debenture stock to 80, the advance underlining favourable suggestions put forward in this column about the stock a few weeks ago. Those who picked it up at that time can safely keep the investment for a further improvement in value.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations Jan. 7th.	Closing Quotations Jan. 14th.	Business done week ended Jan. 14th, 1903. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100				96 —100 xd	96 —100		
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10				2⅜— 3½	2⅜— 3½		
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100				70 — 80	70 — 80		
738,840	Anglo-American Telegraph	Stock	3½%	61s.		48 — 51	48 — 51	48⅝	
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %		90 — 92	90 — 92	91⅛	90⅞
3,105,580	Do. do. do. Deferred	Stock	5s. %	2s.		8 — 8½	8⅝— 9	8⅝	
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	5 %		4 — 4½	4 — 4½		
13,333,300$	Commercial Cable	$100	8 %	8 %		170 —180	170 —180		
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock				93 — 95 xd	93 — 95	94½	93
16,000	Cuba Telegraph	10	4½%	4 %		5 — 6	5 — 6		
6,000	Do. 10 % Pref.	10				13 — 14	13 — 14		
12,931	Direct Spanish Telegraph	5	4 %	4 %		2⅝— 3½	2⅝— 3½		
6,000	Do. do. 10 % Cum. Pref.	5				7 — 8	7 — 8		
60,710£	Direct United States Cable	20	3½%	3½%		9½— 10½	10 — 10½	10½	10
92,800£	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100				98 —101 xd	98 —101		
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %		115 —120	115 —120	115⅛	115
1,955,565	Do. 3½ % Pref. Stock	100				89 — 92	89 — 92	89	
1,534,645	Do. 4 % Mort. Deb. Stock Red.	Stock				105 —108	105 —108	107⅞	
300,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %		10⅝— 11⅛	10 — 11	11 1/16	10
320,000£	Do. 4 % Deb. Stock	Stock				107 —110	107 —110	107	106¾
300,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 3,000, red. 1909	100				99 —102	99 —102		
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25				99 —102 %	99 —102		
180,227	Globe Telegraph and Trust	10	5½%	5½%		8½— 9	8⅝— 8⅞	8⅝	8⅝
180,042	Do. do. 6 % Pref.	10				13 — 13½	12½— 13½	12⅝	12½
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	15 %		25 — 26	24 — 26	24½	23
66,300£	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100				98 —101 xd	98 —101		
17,000	Indo-European Telegraph	25	10 %	10 %		38 — 42	38 — 42		
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100				101 —105	101 —105		
72,680	Montevideo Telephone, Ltd., Ord. Nos. 1 to 72,680	1				⅛— ¼	⅛— ¼		
86,492	Do. do. 5 % Pref., Nos. 1 to 86,492	1				¼— ½	¼— ½		
1,983,333	National Telephone, Pref. Stock	100	5 %	5 %		95 — 97	96 — 98	97½	96½
1,966,667	Do. do. Def. Stock	100	60	64 xd		72 — 74	72 — 74	73½	72½
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %		12½ — 13½	13 — 14		
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %		12 — 13	11½— 12½	12½	
250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %		5⅛— 5⅜	5⅛— 5⅜		
2,000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%		93 — 96 xd	93 — 96		
600,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %		101 —105	99 —103	101½	101½
171,504	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %		⅝— 1	⅝— 1		
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100				97 —100	97 —100		
11,839	Reuter's	8	5 %	5 %		6½— 7½	6½— 7½		
3,303	Submarine Cables Trust	Cert.				110 —120	110 —120		
58,000	United River Plate Telephone	5	7 %	7 %		5 — 5¼ xd	5 — 5¼	5¼	
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5				4½— 5 xd	4½— 5	4⅝	4⅝
179,947£	Do. do. 5 % Debs.	Stock				100 —103 xd	100 —103		
15,609	West African Telegraph, Shares	10				3 — 4	3 — 4		
30,008	West Coast of America, Nos. 1 to 30,000 and 53,001 to 53,008	2½				0 — ¼	0 — ¼		
150,000£	Do. do. 4% Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100				96 — 99 xd	96 — 99		
267,980	Western Telegraph, Ltd., Nos. 1 to 207,980	10	7 %	7 %		11 — 11½	11 — 11½	11 1/16	11
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100				100 —103 xd	100 —103		
400,000	Do. do. 4 % Deb. Stock Red.	100				97 —100 xd	97 —100		
88,321	West India and Panama Telegraph	10	1%			⅛— ⅜	1/16— ⅛	1/16	
34,563	Do. do. do. 6 % Cum. 1st Pref.	10				4½— 5½	4½— 5½		
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10				3 — 4	3 — 4		
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100				98 —101 xd	100 — 103		

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	5½%			3 — 4	3 — 4		
300,000£	Do. do. 5% 1st Mort. Deb. Stock Red.	Stock				75 — 80	75 — 80		
100,000	British Electric Traction	10	9 %	9 %		12⅜— 13⅛	12⅜— 13	12⅜	12⅛
100,000	Do. do. 6 % Cum. Pref.	10				11⅜— 12⅛	11⅜— 12⅛	12⅛	12⅛
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock				124 —127	124 —127	125½	124½
100,000	British Insulated Wire Ord.	5	15 %	10 %		7⅜— 8	7⅜— 8		
100,000	Do. do. 6 % Cum. Pref.	5				5⅜— 6	5⅜— 6		
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100				105 —108	104 —108		
50,000	¶Browett, Lindley & Co. (1899), Ord.	£1	8 %			12/6 to 13/6	12/6 to 13/6		
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %			16/6 to 17s.	16/6 to 17s.		
105,781	Brush Electrical Engineering, Ord., 1 to 105,781	2	5 %	Nil		½— 1½	½— 1½		
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	3 %		1 — 1½	1 — 1½		
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock				100 —103	100 —103		
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock				93 — 98	93 — 98		
35,000	Callender's Cable Construction shares	5	15 %	20 %		14 — 15	14 — 15		
40,000	Do. do. do. 5 % Cum. Pref.	5				5⅛— 6 xd	5⅛— 6	5⅜	
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock				108 —112 xd	108 —112	108½	
1,860,014	Central London Railway, Ord. Stock	Stock		4 %		107 —110	107 —110	109½	109⅜
494,998	Do. do. 4 % Pref. Stock	Stock		4 %		105 —108	105 —108	106½	105⅝
494,998	Do. do. Def. do.	Stock		4 %		108 —112	109 —112		
1,330,000	City and South London Railway	Stock	1½%	2 %	3½%	75½— 76½	76½— 77½	77⅛	76½
85,000	Crompton & Co., Nos. 1 to 85,000	3	8 %	7½%		2⅝— 3	2⅝— 3		
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red.					100 —105% xd	101 —106 %		
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	2½%			⅞— 1	⅞— 1		
17,139	Do. do. "A" shares, 01—017,139	5	2½%			1⅛— 2⅜	1⅛— 2⅜		
344,023£	Do. do. 4 % Deb. Stock Red.	100				73 — 77 xd	73 — 77		
100,000£	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100				77 — 82	77 — 82		
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %		1⅛— 1⅜	1⅛— 1⅜		
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	2				2⅛— 2⅜	2⅛— 2⅜		
182,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock				99 —102	99 —102		
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %		10 — 10½ xd	10 — 10⅜		
200,000	Do. do. 4 % Mort. Deb.	Stock				100 —103	100 —103		
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %		16⅛— 17⅛	16⅛— 17⅛	16⅞	
35,000	Do. do. 4½ % Pref.	5	4½%			5⅛— 5⅜	5⅛— 5⅜		
48,050	Do. do. 4½ Mort. Deb. Stock	Stock				109 —113	109 —113		
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %		19½— 20½ xd	19½— 20½	19⅝	
300,000£	Do. do. do. 4 % 1st Mort. Deb.	100				101 —104	101 —104		
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	1½%		5⅜— 5⅝	5⅜— 5⅝		
10,000	† Do. do. Pref. £10 paid	10				9⅞— 10⅛	9⅞— 10⅛		
7,500	Parker (Thomas), Ltd., Ord., Nos. 1 to 7,500	10				14½— 15½	14½— 15½		
	§Rosling & Fynn 6 % Cum. Pref.	£1	6 %			19/0 to 20/0	— —		
37,350	Telegraph Construction and Maintenance	12	17½%	20 %		37 — 40	37 — 40	39½	37½
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100				101 —104 xd	101 —104		
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3 %		94 — 97	94 — 97		

† Quotations on Liverpool Stock Exchange.
§ From Bradford Share List.
‡ Unless otherwise stated all shares are fully paid.
¶ From Manchester Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, ¼—⅜.
National Electric Free Wiring, ½—1.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 13—14.
Do. do. Pref (£10 pd.), 10—11.

Bank rate of discount 4 per cent. (October 2nd, 1902).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations Jan. 7th.	Closing Quotations Jan. 14th.	Business done week ended Jan. 14th, 1903. Highest.	Lowest.
		‡							
100,000	Blackheath and Greenwich Dist. Electric Light, Ord...	1	..	..	..	⅜—⅝	⅜—⅝	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs. ..	100	..	..	..	110 —113	110 —113	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	5	6 %	8 %	..	10½— 10⅝	10½— 10⅝	..	..
20,000	Do. do. 7 % Cum. Pref. ..	5	..	..	..	10 — 10⅛	10 — 10⅛	..	..
50,000	Charing Cross and Strand Electricity Supply	5	9 %	10 %	..	9¾— 9⅞	9¾— 10	9⅞	9⅞
70,000	Do. do. do. 4½% Cum. Pref. ..	5	..	..	..	5¼— 5⅜	5⅛— 5⅜	5⅛	5⅛
40,000	Do. do. "City Undertaking" 4½% Cum. Pref. ..	5	..	..	..	4¾— 5⅛ xd	4¾— 5⅛	4⅞	..
250,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	103 —105	103 —105	104⅛	103½
44,436	*Chelsea Electricity Supply, Ord.	5	5½%	4 %	..	5¼— 5⅜	5¼— 5⅜	..	..
150,000‡	Do. do. % Deb. Stock Red.	Stock	..	..	..	108 —111 xd	108 —111	110½	108½
70,595	City of London Electric Lighting, Ord. 40,001—110,595	10	0 %	5 %	..	10¾— 11	10 — 11	10 1/16	10½
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	..	..	13 — 14	13 — 14	..	..
400,000‡	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	..	..	..	122 —127 xd	122 —127	..	..
300,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	..	..	..	102 —105 xd	102 —105	..	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000..	10	4 %	4 %	..	8¾— 9⅛	8¾— 9⅛	..	..
20,000	Do. do. do. 6 % Pref., 40,001—60,000..	10	6 %	..	..	12 — 13	12 — 13	..	..
400,000‡	Do. do. 4½% Deb. Stock, Prov. Certs. (all paid) Red ..	..	..	..	..	109 —112	107 —110	108⅜	..
50,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	..	6¾— 7	6¾— 7	6 15/16	6
30,000	Do. do. 6 % Cum. Pref.	..	..	..	..	6 — 6¼	6 — 6¼	6 1/16	..
140,000	Do. do. 4½% 1st Mort. Deb. Stock ..	100	..	..	..	107 —110	107 —110	..	..
21,000	Kensington and Knightsbridge Electric, Ord.	5	12 %	10 %	..	10 — 11	10 — 11	..	..
90,000	Do. do. 4 % Debenture Stock ..	Stock	..	..	..	101 —104	101 —104	..	..
110,000	ondon Electric Supply Corporation, Limited, Ord.	3	..	..	..	1¾— 2⅛	1¾— 2⅛	..	..
49,840	Do. do. do. 6 % Pref. ..	5	..	..	..	5 — 5⅛	5 — 5⅛	..	..
250,000‡	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	..	..	..	96 — 98	96 — 99	97⅛	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	6 %	6⅓%	..	16½— 17⅛	16½— 17⅛	17⅛	16⅝
220,000‡	Do. do. 4½% 1st Mort. Deb. Stock	..	..	..	..	107 —112 xd	107 —112	..	..
250,000‡	Do. do. 3½% Mort. Deb. Stock Red	Stock	..	..	..	98 —101 xd	98 —101	100½	..
10,852	Notting Hill Electric Lighting	10	7 %	6 %	..	14½— 15½	14 — 15	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	..	14½— 15½	14½— 15½	..	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	7 %	7 %	..	8¾— 9⅛	8¾— 9⅛	..	..
150,000‡	Do. do. do. 3½% Deb. Stock Red ..	100	..	..	..	97 —100 xd	97 —100	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	..	..	..	1⅞— 2⅛	2 — 2⅛	..	..
50,000‡	Do. do. 4% Deb.	100	..	..	..	80 — 90	80 — 90	..	..
65,000	South London Electricity Supply, Ord.	5	..	..	..	3 — 3⅛	3 — 3⅛	3 1/16	3 1/16
30,000	Urban Electric Supply, Ord.	5	..	..	..	4⅞— 5⅛	4⅞— 5⅛	5⅛	4⅞
30,000	Do. do. 5 % Cum. Pref.	5	..	..	..	4¾— 5⅛	4¾— 5⅛	..	..
110,000	Westminster Electric Supply, Ord.	5	10½%	10½%	..	11 — 12	11 — 12	11⅞	11⅞
28,141	Do. do. 5 % Cum. Pref.	5	..	..	..	6⅛— 6⅞	6⅛— 6⅞	6 1/16	..

* Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, January 14th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	22/-	22/-	..
a ,, Oxalic	per cwt.	32/-	32/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	42/-	42/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a ,, ,, ...	per ton	£30	£30	..
a Bleaching powder	per ton	£4 10	£4 10	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£13	£13	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90 %)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£17 10	£17 10	..
a Lead, Nitrate	per ton	£24	£24	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks ..	per lb.	3d.	3d.	..
a ,, Caustic (75/80%)	per ton	£24	£24	..
a ,, Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	130/-	130/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 5	£6 5	..
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£3	£3	..
a ,, Bichromate, casks	per lb.	2¼d.	2¼d.	..

METALS, &c.				
b Aluminium Ingots, in ton lots ..	per ton	£148	£148	..
b ,, Wire, in ton lots ..	per ton	£224	£224	..
b ,, Sheet, in ton lots ..	per ton	£191	£191	..
p Babbitt's metal ingots	per ton	£40 to £130	£40 to £130	..
c Brass (rolled metal 2" to 12") basis	per lb.	6¼d.	6¼d.	..
c ,, Tube (brazed)	per lb.	8¼d.	8¼d.	..
c ,, ,, (solid drawn) ..	per lb.	7¼d.	6¾d.	..
c ,, Wire, basis	per lb.	7¼d.	6¾d.	..
c Copper Tubes (brazed)	per lb.	8¾d.	8¾d.	..
c ,, ,, (solid drawn) ..	per lb.	9d.	9d.	..
g Copper Bars (best selected ..	per ton	£67	£65	£2 inc.

METALS, &c. (*continued*).		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£67	£65	£2 inc.
g ,, Rod	per ton	£67	£65	£2 inc.
e ,, (Electrolytic) Bars ..	per ton	£59	£55	£4 inc.
e ,, ,, Sheets ..	per ton	£73	£73	..
e ,, ,, Rod ..	per ton	£61	£61	..
e ,, ,, H.C. Wire	per lb.	7¼d.	7d.	¼d. inc.
f Ebonite Rod	per lb.	3/-	3/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/4½	1/4½	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/4½ to 3/7½	3/8 to 3/10½	inc.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants)	per ton	47/1	48/-	11d. dec.
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	47/6 to 50/-	..
i ,, Wire, galvanised No. 8 ..	per ton	£9 15	£9 15	..
g Lead, English Ingot	per ton	£11 10 to £11 12 6	£11 5 to £11 7 6	5s. inc.
g ,, ,, Sheet	per ton	£13	£13	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£8 15	£8 15	..
d Mica (in ginal cases) small ..	per lb.	3d. to 9d.	3d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large ..	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	11½d. to 1/2	11½d. to 1/2	..
p ,, rolled bars & rods	per lb.	1/- to 1/3	1/- to 1/3	..
p ,, ,, strip & sheet	per lb.	From 1/2	From 1/2	..
o Platinum	per oz.	£4	£4	..
p Silicium Bronze Wire	per lb.	9d. to 1/-	9d. to 1/-	..
i Stee., Magnet, acc'd'g to desc'p'n	per ton	£58	£58	..
i ,, ,, in bars		From £15 to £40	From £15 to £40	..
g Tin, Block	per ton	£129 to £130	£126 to £127	£3 inc.
g ,, Foil	per lb.	1/6	1/6	..
n ,, Wire, Nos. 1 to 16	per lb.	1/7½	1/7	½d. inc.
p White Anti-friction Metals—				..
"White Ant" brand ..	per ton	£36 to £60	£36 to £60	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	7d.	7d.	..
j ,, 6 lea. Flax	per lb.	5¾d.	5¾d.	..
j ,, 3 ply 10 lbs. Russian ..	per lb.	4 1/12d.	4 1/12d.	..
j ,, 10 lbs. Russian, single ..	per lb.	4¼d.	4¼d.	..
j ,, 180 lbs. Jute rove ..	per ton	£11	£11	..
k Zinc, Sh't (Vieille Montagne bnd.)	per ton	£23	£23	..

Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons., Ltd. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

Quotations supplied by { *f* India-Rubber, G.P. and Teleg. Works *g* Messrs. James & Shakspeare. [Co., Ltd. *h* Messrs. Edward Till & Co. *i* Messrs. Bolling & Lowe. *j* Messrs. Walter H. Hindley & Co., Ltd.

Quotations supplied by { *k* Messrs. Morris Ashby, Limited. *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company Ltd.

TRAFFIC RECEIPTS.

Company.	Week ending	Receipts for the week. Am'nt.	Inc. or dec.*	Total to date. Am'nt.	Inc. or dec.*	Miles open. This year.	Last year.
		£	£	£	£		
Blackburn Corp. Trys. ..	Jan. 9	676	+ 73	33,786	+ 4,345	12¼	12¼
Blackpool and Fleetwood	,, 10	192	+ 48	298	+ 80	7½	7½
Bristol Trys. & Car. Co.	,, 9	4,347	+324	—	—	28	28
British Elec. Trac. Co.:—							
Barnsley	,, 2	187	—	1,400	—	—	—
Devonport	,, 2	378	— 17	22,424	+ 1,185	5	5
Dudley—Stourbridge..	,, 2	900	+163	39,697	+ 5,057	18⅜	18⅜
Gateshead	,, 2	972	+261	40,778	+ 8,577	10½	9⅜
Gravesend—Northfleet	,, 2	194	—	4,455	—	3½	3½
Greenock—Pt. Glasgow	,, 2	522	+ 61	26,060	+13,592	7¾	7¾
Hartlepool	,, 2	949	+ 23	18,181	+ 1,374	6¾	4¾
Kidderminster	,, 2	110	+ 17	6,414	+ 86	4½	4½
Merthyr	,, 2	183	+ 1	10,405	— 1,796	3	3
Middleton	,, 2	274	—	11,545	—	8½	—
Oldham—Ashton ..	,, 2	529	+ 88	27,980	+ 1,762	8	8
Poole	,, 2	262	+ 90	13,478	+ 212	3½	3½
Potteries	,, 2	1,545	+145	79,837	+ 5,640	28½	28½
Rotherham	,, 2	73	+ 24	2,061	+ 267	—	—

Company.	Week ending	Receipts for the week. Am'nt.	Inc. or dec.*	Total to date. Am'nt.	Inc. or dec.*	Miles open. This year.	Last year.
		£	£	£	£		
B.E.T. Co. (*continued*)—							
Southport	Jan. 2	258	+126	13,899	+ 4,991	5½	5½
South Staffordshire..	,, 2	797	+ 12	39,348	— 1,661	21½	21½
Swansea	,, 2	404	+ 56	15,000	+ 1,651	5½	5½
Taunton	,, 2	60	— 7	3,383	— 393	1½	—
Tynemouth	,, 2	269	+ 14	15,143	+ 2,217	3½	3½
Weston-super-Mare..	Dec. 31	37	—	5,626	—	2½	—
Wolverhampton Dist.	Jan. 2	382	+280	12,234	+ 8,087	10½	7½
Central London Railway	,, 10	6,967	+303	13,650	+ 878	6	6
City and S. London Ry.	,, 11	3,411	+377	6,848	+ 688	6½	6½
Doncaster Corp. Trys. ..	—.—	—	—	—	—	5½	—
Dover Corporation Trys.	,, 10	182	+ 2	279	— 33	3	3
Dublin United Trys. ..	,, 9	4,386	— 10	5,577	— 99	46	8
East Ham Tramways ..	,, 3	473	+148	14,042	+ 3,167	5	46
Glasgow Corp. Trys. ..	,, 10	12,025	+1,136	393,620	+ 765	62	42½
Liverpool Overhead Ry.	,, 11	1,502	+ 49	2,998	+ 143	6½	50½
Newcastle Corp. Trys. ..	,, 3	2,940	—	—	—	35	6½
Sunderland Corp. Trys.	,, 4	1,217	— 60	—	—	17½	17½

* Compared with the corresponding period of 1901.

INSTITUTION OF ELECTRICAL ENGINEERS.

THE PHOTOMETRY OF ELECTRIC LAMPS.

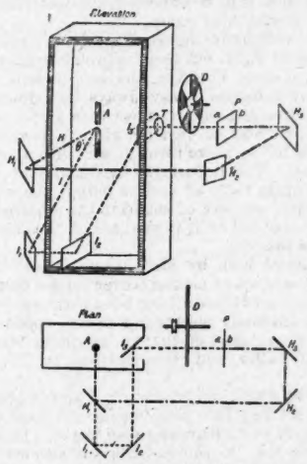
By Dr. J. A. Fleming, M.A., F.R.S., Member.

(*Abstract of Paper read December 11th, 1902.*)

(*Continued from page 76.*)

Before proceeding to discuss the special difficulties connected with the photometry of arc lamps, it may be well to describe the arrangement which the writer has found in practice to work well for determining the form of the polar curve of luminous intensity of arc lamps.

Owing to the unsymmetrical distribution of light from an arc lamp, it is more important than in the case of the incandescent lamp to determine the luminous intensity in different directions, and to set these out in the form of a polar curve, the radii of which represent to scale luminous intensity. Various devices have been used for this purpose, but a convenient arrangement is as follows:—On a suitable base is erected a wooden gallows about 9 ft. high and 3 ft. wide. From the top of this, the arc lamp to be investigated is suspended. In the two uprights of the gallows are two openings through which pass brass tubes or hollow bearings, to which is connected another rectangular frame, as shown in the diagram (see fig. 6). The lamp is placed so that the arc A is exactly in line with the axis of these hollow trunnions. On the outside of one of the uprights is a circular scale of degrees, and the swinging frame carries a pointer, by means of which its angular position relatively to the horizon is determined. The swinging frame also carries three plane mirrors, I_1, I_2, I_3, which are set at angles of 45°, and catch the ray from the arc lamp, and reflect it down one of the hollow trunnions. The ray, therefore, emerges in the same direction, no matter what may be the angular



A, Arc lamp; H_1, H_2, H_3, I_1, I_2, I_3, Mirrors; P, Photometer disc; D, Fox-Talbot sector disc.

Fig. 6.—Arc Lamp Photometer (Fleming).

position of the swinging frame. This frame can be so set as to catch a ray coming from the arc at any angle above or below the horizon. It is quite possible, by means of a standard incandescent lamp, to determine the total and constant percentage loss of light by the three mirrors, at each of which the ray is reflected at an incidence of 45°, and hence to apply the necessary correction to the measured intensity of the selected ray. By employing a photometer and a standard glow lamp, measurements can be made of the luminous intensity of the arc in any direction relatively to the horizontal plane through the arc. This direct measurement is often rendered difficult because the electric arc shifts its position continually, and there is, therefore, a periodic waxing and waning of the light in any direction. The difficulty, however, can be overcome by photometering the arc against itself, or, in other words, comparing the luminous intensity of the ray coming from the arc in any direction with that of the ray coming off in a horizontal direction. This is accomplished by fixing three other mirrors, H_1, H_2, H_3, to reflect round the ray coming in a horizontal direction from the arc, and make it coincide in direction with the three times reflected ray coming from the arc at any angle above or below the horizon. In each case the ray suffers reflection at three mirrors placed at angles of 45°, hence there is no difference in the loss by reflection, and both the rays are weakened in the same ratio.* We have then to determine the ratio of the intensities of these two rays. One way by which it can be achieved is by employing the device, much used by Sir W. de W. Abney, viz., a rotating metal disc having sectors cut out of it, the apertures in which can be more or less closed up whilst the disc is running* (see fig. 7). If we interpose such a rotating disc with variable apertures in it, in the path of the brighter ray or in the paths of both rays, we can weaken the stronger ray until the two are of the same intensity. By the use of a Foucault or Rumford photometer, and a pair of such rotating discs, we can accordingly determine the ratio of the luminous intensity of the ray coming from the arc in any inclined direction to that emitted in a horizontal direction. The question

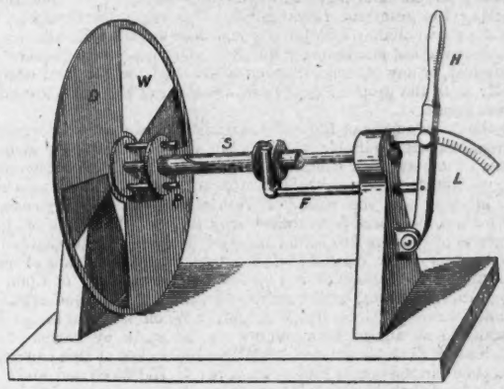


Fig. 7.—Fox-Talbot-Abney Variable Aperture Disc.

whether the Fox-Talbot sector disc reduces the intensity of a transmitted ray in the proportion of the total open sectorial angle to 360° has often been raised. Experiments made in the Pender Laboratory for the author by Mr. W. C. Clinton support the affirmative conclusion generally accepted.

A single observation, or rather the mean of a number of observations, taken against a standard glow lamp will enable us to determine the mean absolute horizontal luminous intensity, and hence the polar curve of luminous intensity can be plotted out. In taking the absolute luminous intensity of the arc, the most convenient standard to use is the glow lamp of the large bulb pattern, which is worked at an efficiency of 2½ watts per candle.

There is no reason why manufacturers of arc lamps should not furnish on demand the polar curve of luminous intensity, because such a curve at once enables us to determine the mean spherical candle-power, and also the illumination on the surface of a roadway, due to the arrangement of any number of such arc lamps at known heights and distances. The geometrical constructions for doing this are tolerably well known, but it may perhaps be convenient to give them here.

Let A (see fig. 8) be an arc placed on a post X A standing on a roadway X Y. It is required to determine the illumination at any point P. Draw the line A P, and round A set off the polar curve of candle-power of the arc as determined experimentally. Let G E F be a semicircle just touching this polar curve. On the other side of the line X A and on the base G F describe a rectangle K F G H of

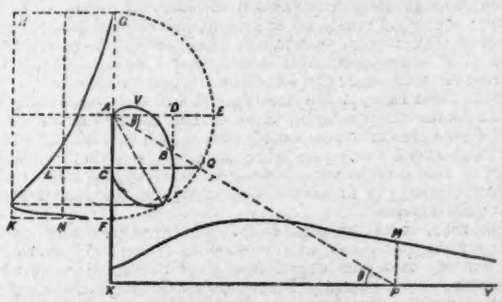


Fig. 8.—Arc Lamp Polar Curve of Intensity and Horizontal Illumination Curve.

which the side K F is equal to the maximum radius vector of the polar curve. Draw the horizontal line through A, draw a line B D vertically through B, and through Q where A P intersects the semicircle draw Q C horizontally and produce it to L, setting off a length C L equal to A B. At P set up P M perpendicular to X Y, and make P M equal to the quotient of B D divided by $(A P)^2$. This can be done at once by means of a slide rule.

Then if A B represent to any scale the luminous intensity of the arc in the direction of A P M P will represent the horizontal illumination on the roadway at P.

If other radii of the polar curve are drawn and the same construction followed out, then the extremities of all the lines similar to C L will define a curve G L F, called the Rousseau curve, which has the property that its mean ordinate F N is the so-called "mean spherical candle-power of the arc† Similarly, the upper ex-

* Many forms of arc lamp photometer have been devised, such as that of M. Rousseau, in which the ray is reflected from a mirror at various angles of incidence, but this requires a correction at every angle for loss by reflection.

* This method for weakening a ray of light in a known ratio was originated by Mr. Fox-Talbot, whose name is well known in connection with the development of photography.

† See *La Lumière Électrique*, Vol. xxxvii., p. 415.

tremities of all lines like P M define a curve X M Y, the ordinates of which define the illumination on a horizontal surface.

Accordingly, if we have the polar curve of luminous intensity of an arc when included in its globe, we can, by means of a simple geometrical construction on the drawing board, set out a curve whose ordinates represent the illumination produced on a roadway by any number of such arc lamps placed at any distances and at any heights. For the illumination produced by all the lights is the sum of the separate illuminations. As a general rule, it will not be necessary to consider more than the two adjacent arc lamps in obtaining the resultant illumination. We are able, therefore, to set out a curve along a line joining the base of the two arc lamp-posts showing the maximum, minimum, and mean illumination in candle-feet, or any other similar units, on the roadway, and decide exactly as to the proper heights and distances of the arcs to obtain a given result.

If the polar curves of luminous intensity of arc lamps of various descriptions are available, they enable us to make a comparison between them as street illuminants when arranged in any suggested way, without further experiments. Manufacturers of arc lamps are not, however, in the habit of furnishing this very necessary information, but there is no reason why they should not do so, just as makers of engines furnish an indicator diagram for an engine.

With this polar diagram at hand we have the means of predetermining the effect of any proposed arrangement of open or closed, direct-current, or alternating-current arcs, arranged at stated distances or on posts of stated heights. When once the lamps are in position, an illumination survey can be made by means of an illumination photometer, and extensive researches of this character have been carried out in past years by Sir W. H. Preece and Mr. A. P. Trotter.* What is required, however, is a means of predetermining the illumination before making expensive experiments. It is usual in these surveys to calculate or to measure the illumination either on the pavement surface or at a height of about 4 or 5 ft above the pavement. The measurement most required is that of the illumination on a horizontal or vertical surface about 5 ft. above the pavement or road surface, because it is on the illumination at this point that our ability to distinguish objects in the street depends.

(To be continued.)

ON ELECTRONS.

By Sir Oliver Lodge, F.R.S., Vice-President.

(Paper read in London, November 27th, 1902.)

(Continued from page 78.)

Increase of Inertia Due to Very Rapid Motion.

But now arises the question whether the distribution of charge on a charged body, together with its lines of force, will remain constant and unaltered while the body is rapidly moving; because if the distribution of lines of force is altered, then perhaps the inertia due to their lateral motion may be altered too.

Thus, for instance, imagine that the lines of force of a body in motion became more concentrated towards the axis or line of motion; the effect would be at once to diminish the lateral component of their motion, therefore to diminish the magnetic force which that lateral component causes, and thus to diminish the apparent or electro-magnetic inertia of the moving charge.

On the other hand, if the lines opened out and became concentrated towards the equator, or plane normal to the line of movement, then a greater component of their motion would be of a kind suitable to excite a magnetic field; moreover, since both the fields would by this concentration increase in intensity, the whole transmission of energy (V EH) would be greater, and the inertia would apparently increase.

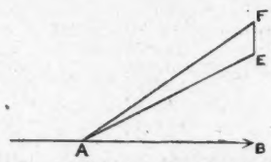
Thus, then, it may be possible that electric inertia may depend in some fashion on speed, a thing unknown in ordinary mechanics. I do not say that such dependence must be *untrue* in ordinary mechanics; on the contrary, I feel reasonably sanguine that it will be found true for matter moving sufficiently fast, and that it may even have a practical influence on some exceptionally rapid movements in astronomy. But however this may be, there is no doubt that theory points to an increase of electro-magnetic inertia at excessively high speeds, and Mr. Heaviside has calculated its amount.

It will be observed that when a charge moves, it generates circular magnetic lines of force. Now these magnetic lines are not stationary, but are themselves moving at the same rate as the body, hence they generate fresh electrostatic lines, *i.e.*, cause an electric displacement away from the axis, which displacement is superposed upon the original radial displacement (away from or toward the centre) due to the charge.

At ordinary, at even violent speeds, this second order electric effect is insignificant, but it is there all the time, and must not be ignored when the speed becomes extravagantly high. It rapidly rises into prominence when the speed approaches the velocity of light, but at any speed much smaller than this such a second order effect i vanishingly small.

Its effect will be, as Mr. Heaviside showed, to alter the distribution of the charge, making it move away from the poles and concentrate towards the equator of the charged sphere, when the speed is very great, ultimately becoming wholly concentrated upon the equator, all the rest of the sphere being denuded when the speed attains that of light. And the electric lines of force will then be opened out into a fan or equatorial plane, like the spokes of a wheel which is rushing furiously along an elongated axle, the circumference of the wheel representing the direction of the magnetic field.

The magnetic force due to motion can be shown to depend on the ratio of the speed of the motion to the velocity of light, u/v. The secondary electrostatic force due to the motion of this magnetic field likewise depends on the same ratio. Hence the second order disturbance of the original uniform electrostatic field will be of the order u^2/v^2, and whenever we can afford to neglect quantities of this order, the distribution, and therefore the inertia, of the moving charge continue practically constant.



A is the charge, A B its line of motion, and A E its electric force in a certain direction when stationary; E F is the magnetically induced electric component due to the motion, and A F is the resultant electric force which replaces the original force, A E. The magnetic force to the motion of which E F is due is perpendicular to the paper, and is itself caused by the motion; hence E F is a small quantity of the second order, for speeds distinctly less than that of light.

But when its speed of motion begins to approach the velocity of light, say, even no more than one-tenth of that speed, then a disturbance of 1 per cent. is to be expected, and something like a 1 per cent. increase of inertia must occur.

The complete investigation makes the inertia infinite when the speed reaches that of light, but there is probably no need to press this to extremes; clearly, however, the inertia will then be very great, and possibly therefore it may always be impossible to make matter, or at least charged matter, move with a speed greater than that of light. There may be ways out of this, however, just as it is possible for a bullet to move through air with a velocity greater than that of sound. This is managed by the violent adiabatic condensation of the air in front of such a bullet, the effect being to raise the appropriate velocity of sound to the required value.

If there is any way out of it in the case of the ether, however, it is not likely to be *this* way.

It has been shown both by Mr. Heaviside and by Prof. J. J. Thomson that if the speed of motion *is* ever greater than that of light, the fan or radial plane of lines of force bends backwards, and becomes a conical surface, gradually closing up as the speed increases—an effect singularly reminiscent of the conical pulse travelling with a sufficiently rapid bullet, and demonstrated in Mr. Boys's bullet photographs.

No known speed which can be conferred upon matter is sufficient to bring this latter effect into prominence. The quickest available carriage is the earth in its journey round the sun, 19 miles a second, or 60 times faster than a cannon-ball; but the earth's velocity is only the $\frac{1}{10000}$th of the speed of light, and consequently any spurious inertia due to its orbital motion is only one part in a hundred million; and even the accuracy of astronomy could not display any effect of that order of magnitude.

There are stars which move 200 miles a second, but even these have only one-tenth per cent. of the speed of light, and the excess inertia will be only 1 part in a million. The only known place where charges or charged matter move at speeds greater than this is in a vacuum tube. There the cathode-propelled particles are flying 20,000 miles a second or one-tenth the speed of light, and they may have 1 per cent. excess inertia; or more if they can be persuaded to go still faster.

The substance of the above digression on the effect of rapid motion was written in connection with the Liverpool meeting of the British Association in 1896, and was communicated orally and very briefly to Sec. A in a discussion on the mechanism of the production of X rays; for I then thought that unless great speeds sufficient to disturb the static field were reached by the cathode particles they would not serve as efficient producers of the rays when suddenly stopped; but the matter has been gone into more fully now, and not only Mr. Heaviside's Vol. 1 of "Electro-magnetic Theory," p. 57, may be referred to, where the circumstances of sudden stoppage of a charged body moving with the speed of light are illustrated, but also a paper by J. J. Thomson in the *Philosophical Magazine* for February, 1898, dealing powerfully with the more general problem.

APPENDICES TO PART II.

Appendix C.—On Electricity and Gravitation.

Referring back to an article of mine in the *Philosophical Magazine* for November, 1882, page 358, we find the fundamental and necessary relation between constants stated thus, where M shall stand for magnetic pole and γ for Cavendish's gravitation constant

$$e^2/K = M^2/\mu = \gamma m^2 = F l^2,$$

F being force and l being length.

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* "The Distribution and Measurement of Illumination," by Mr. A. P. Trotter, A.M.Inst.C.E. (*Proc. Inst. Civil Eng.*, Vol. 110, 1891-1892).

If it is now going to turn out that a mass is composed of electric charges, it might seem as if e and m were quantities of the same nature, and were only numerically connected, whence it would follow that κ and γ were of similar kind; in other words, Faraday's dielectric constant would become closely related to Cavendish's gravitation constant, and *weight* as well as *mass* would be traced to electricity. But such a deduction is unwarranted; there is nothing to prevent essentially different properties of the ether being involved in the two kinds of force—gravitative and electric.

As to the nature of the gravitation constant itself we have

$$\gamma = \frac{F l^2}{m^2} = \frac{l^3}{mt^2} = \frac{v^2}{m/l} = \frac{\text{sq. of velocity}}{\text{linear density}} = \frac{\text{energy/mass}}{\text{mass/length}}.$$

It is clear that if gravitation is in any sense of electric origin, it must be a second order disturbance superposed upon the main electric effect, and be independent of sign. It would, in fact, depend upon e^4. For the gravitative force between two electrons at distance r would be

$$F_1 = \gamma \frac{m^2}{r^2} = \frac{\gamma}{r^2}\left(\frac{2\mu e^2}{3a}\right)^2.$$

The electric force between the same two electrons at the same distance is

$$F_2 = \frac{e^2}{\kappa r^2}.$$

Therefore the ratio of the gravitative to the electric force at any distance is constant and equal to

$$\frac{F_1}{F_2} = \frac{4\mu^2\kappa\gamma}{9a^2}e^2 = \frac{4\mu\gamma e^2}{9a^2v^2} = \frac{2\gamma}{v^4} \cdot F_0,$$

where F_0 is the electric force between electrons in contact, and v is the velocity of light.

Numerically this ratio of the two forces is

$$\frac{F_1}{F_2} = \kappa\gamma\left(\frac{m}{e}\right)^2 = \frac{1}{9 \times 10^{20} \times 1{\cdot}5 \times 10^7}\left(\frac{1}{10^7}\right)^2 = 10^{-42},$$

so the electric force exceeds the gravitative as much as the globe of the earth exceeds in bulk an ultra-microscopic object.

When there is an agglomeration of electrons of opposite sign their electric influence at a distance disappears, but their gravitative influences are simply added. So with 10^{21} mixed electrons in each of two bodies at any distance apart, the gravitative force between them will equal the electric force between two single electrons at the same distance.

In my 1885 report to the British Association on electrolysis, page 745 of the Aberdeen volume, the following statement is made:—"If the opposite electricities were extracted from a milligramme of water and given to two spheres one mile apart, those two spheres would attract each other with a force equal to the weight of 12 tons."

Appendix D.—Dimensions of e/m Ratio.

The reciprocal of the electro-chemical equivalent of a substance e/m may be expressed as regards dimensions in several ways, one of which exhibits it as a certain large numerical multiple of $\sqrt{(\kappa\gamma)}$, the geometric mean between Faraday's dielectric constant and Cavendish's gravitation constant. For hydrogen, this numerical multiple is of the order 10^{18}; for silver, 10^{16}.

Another way is obtained by writing

$$e^2 = \kappa F l^2 = \frac{ml}{\mu},$$

whence it follows that

$$\frac{m}{e} = \frac{\mu e}{l} = \sqrt{\left(\frac{\mu m}{l}\right)},$$

and so e/m can be expressed in $\sqrt{\left(\frac{\text{centimetres}}{\mu \text{ grammes}}\right)}$.

The artificiality of these dimensions is due to the fact that e and m have been conventionally measured in different ways; m is measured by ratio of applied external force to acceleration, while e is measured by repulsive force self-exerted on a similar charge at given distance.

If we express μ as a density (see "Modern Views of Electricity," Appendix P), the electro-chemical equivalent comes out as expressible in grammes per square centimetre, that is to say, a surface density.

It is noteworthy that while $\sqrt{(\kappa\mu)}$ is of the same dimensions as $1/v$, $\sqrt{(\kappa\gamma)}$ corresponds to $1/\epsilon$, where ϵ is an electro-chemical equivalent.

(To be continued.)

MULTIPLE-UNIT VOLTAGE SPEED CONTROL FOR TRUNK LINE SERVICE.*

By H. WARD LEONARD.

In February, 1894, I read a paper before this Institute describing a system which I considered applicable to the operation of a trunk line electric railway. The essential features of this system were:

1. The generation and transmission of a high-tension single-phase alternating current, the power houses being placed as far apart as the insulation of an alternating-current transmission would permit.
2. The entire elimination of sub-stations.
3. A transformation of the energy upon the locomotive so as to secure a voltage speed control for the electric motors, thereby obtaining smooth acceleration and efficient control of the locomotive at any desired speed and in either direction.

At that time there were no engineers, so far as I know, who agreed with me that these features were essential for the operation of a trunk line railway by electric motors.

In the recent past, however, many prominent engineers, both abroad and in this country, have declared themselves in favour of these essential features, and I therefore feel warranted in describing an improvement upon the system I originally proposed, by which I can secure the important and now well-understood advantages of a multiple control of any desired number of locomotive units.

The accompanying cut (see next page) illustrates diagrammatically one form of my multiple unit voltage speed control as applied to two locomotive units for trunk line service.

The current is generated in the form of a single-phase alternating current at as high an E.M.F. as is practicable to-day, say 20,000 volts. A moving contact leads the single-phase alternating current upon the locomotive. If desired, static transformers can be placed at suitable points along the line of the railway, which will reduce the initial E.M.F. to any desired lower E.M.F. upon the contact conductor.

In many instances it may be desirable to place upon the locomotive a transformer S′ for reducing the tension of the alternating current led to the synchronous motor A^1.

A single-phase synchronous motor on the locomotive receives this alternating current, and is driven by it continuously at a practically constant speed; the current, after passing through the motor, being led to ground through a moving contact. This single-phase motor A^1 drives continually a small exciter E^1 and also a large continuous current dynamo D^1, whose field is separately excited by the exciter E^1, and has in its field circuit a reversing field rheostat R^1. The armatures of the propelling motors are connected in multiple directly across the terminals of the armature of the dynamo D^1. The field magnets of the propelling motors M^1 are separately and constantly excited by the exciter E^1.

By manipulating the reversing field rheostat R^1, the current through the armatures of the motors M^1 necessary to obtain the required tractive effort can be obtained at any desired voltage, from the lowest voltage to the full speed voltage, and in either direction.

A perfectly smooth and rapid acceleration can thus be obtained with minimum energy from the source of supply.

The simultaneous multiple control of the several locomotive units is obtained by means of the four small wires 1, 2, 3, 4, which are lead along the train.

In this cut the operator is supposed to be upon the locomotive I. The exciter E^1, which is producing a constant E.M.F., has its terminals connected to the wires 1 and 2. Across these wires 1 and 2 are connected the field windings of all the propelling motors on the two locomotives, so that they are all constantly and fully excited.

The wires 3 and 4 are also supplied by a current from the exciter E^1, but the reversing field rheostat R^1 is in the path of this current. The fields of the two dynamos D^1 and D^2 are connected in multiple across these wires 3 and 4 which extend along the train.

It will be evident that by manipulating the reversing field rheostat R, the operator can vary simultaneously and similarly the field exciting currents supplied to D^1 and D^2, and that therefore he can cause the voltage of these two dynamos to vary in exact unison from zero to the maximum voltage in either sense. Thus, the operator can cause the two locomotives to start, accelerate, run at full speed, retard, and reverse in perfect unison, always dividing the load perfectly under these various conditions.

By placing the controller R^1 in its open position and going to the other locomotives, the operator can similarly control the two locomotives simultaneously by means of the controller R^2.

By the use of this system I expect to be able to secure the following advantageous features:—

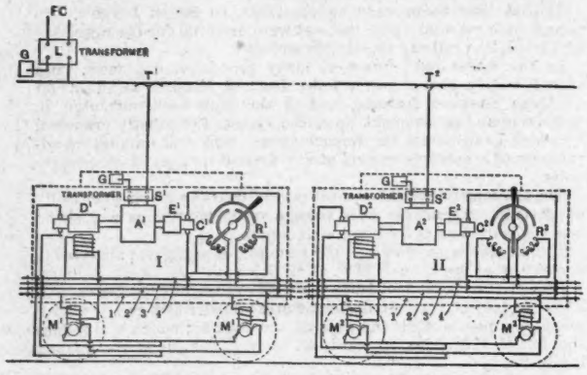
1. The haulage over existing roadbeds, grades, bridges, &c., of very much heavier trains than can be hauled by any steam locomotive.
2. A material reduction in the cost of maintenance of the locomotives as compared with steam locomotives.
3. A material saving in the maintenance of the roadbed because of the absence of hammer blow, shouldering, rocking and skidding.
4. A material increase in the weight of the train which could be hauled around a certain curve by a locomotive having a certain weight on drivers.
5. A material increase in the load which could be started upon a certain grade by a locomotive having a certain weight on drivers.
6. A material reduction in the dead load necessarily hauled by a steam locomotive, represented by the part of the steam locomotive and tender not on drivers.
7. A very large increase in the number of trains of given weight and speed which could be operated from a given power house compared with the series-parallel or cascade systems. Or, to state this another way, a very much higher rate of acceleration with the same maximum output from the power house, the same conductors, the same weight per train and the same watt hours per ton mile, than is possible with the series-parallel or cascade systems.
8. As each locomotive unit can be equipped with any desired number of driving axles and any desired number of locomotives can

* Read at the meeting of the American Institute of Electrical Engineers, New York, November 21st, 1902.

be operated under multiple control, the amount of power which can be applied to a single train and controlled by a single operator is practically unlimited.

9. Fifty per cent. of the energy now wasted on friction brakes can be saved in the form of useful electrical energy restored to the system.

10. The first cost of equipment will be very much less than that of any system, for equivalent service, which involves the use of sub-stations.



Two Locomotive Units with Multiple Unit Voltage Speed Control.

11. The cost of haulage per ton mile will be greatly reduced as compared with steam locomotives, especially because of the large increase in the weight of the train which can be hauled.

12. Difficulties due to electrolysis would be reduced to a minimum.

Discussion.*

Mr. S. F. Dodd: There is one question I would ask Mr. Leonard, and that is, what facts he can give us in regard to the weight and efficiency of such a locomotive as he describes. It will be impossible to apply such a system in single or small units, and the only field for such a locomotive will be for trunk-line service. Now, let us consider a large locomotive like the Baltimore and Ohio tunnel locomotive, whose weight is 96 tons. I do not know exactly how much waste room or waste weight there is; I do not think there is much of either. These locomotives are operated by a motor generator set which weighs 36 tons; it raises the voltage from 500 volts to 700 volts. Suppose it generated 700 volts. To develop that amount of current it would require about a 750-kw. motor-generator weighing somewhere between 50 tons and 60 tons, and making the total weight 150 tons. Thus, it will be seen, for large locomotives they would get a weight somewhere in the neighbourhood of 150 tons, which will cut the weight efficiency down less than we could expect to have it in electric motors of this style.

Mr. N. W. Storer: Mr. Dodd has struck the nail on the head. Such a system, I believe, will increase the weight of the locomotive far beyond what is ordinarily required for the power of the locomotive. I believe if you take a large locomotive scarcely any excessive weight will be necessary, particularly if you take into account the motors and other necessary parts, and, I believe, if you add to that a motor-generator outfit you will have a locomotive which is 50 per cent. heavier than it should be.

Mr. H. Ward Leonard: I will not spend any time on the Baltimore and Ohio locomotives, which, although historic, we all know are absolutely uncommercial for freight haulage on trunk-line service. I think it is likely there is not much room on that particular locomotive for a motor-generator. I know the company which built it considered whether it should put a motor-generator on it, and apparently it did not find room for it. As to the particular question of the effect of the motor-generator in locomotive practice, I beg to point out that the best constructed locomotives which have been made in recent years are the Decapod locomotives, and these have about 50 per cent. of the entire weight on drivers, which is put there to secure better power results and to secure larger tractive effects. The next difficulty that was met with was that they would skid the wheels if the weight on the drivers was not sufficient to take care of the power produced, and various complicated devices have been invented in recent years to shift a part of the weight of the locomotives, and endeavour to secure more weight on the drivers. It is therefore not only important, but really essential, that you get more weight upon the drivers of any locomotive, such as I am considering. Furthermore, admitting for the sake of argument that the point is well taken that the weight hauled is increased by the motor-generator, I still wish to point out that a motor-generator would not be designed whose weight would compare with the weights of the motor, or with the weight of the motor-generator, which is put in a sub-station. A motor-generator employed on a locomotive would resemble closely a generator driven by a steam turbine as to size and weight. Members who are particularly interested in following the matter further will find quite detailed figures as to the weight of a motor-generator relative to the total weight of the locomotive in a paper by Mr. Huber last March describing locomotives for the Zurich Co. which were built on my system, and which will go into commercial use in the next few months. The present steam locomotive in having 50 per cent. of its weight on drivers, could double its present horse-power, and such a locomotive would doubtless show great economies in the haulage of freight. There is scarcely a railroad in the United States to-day that is not struggling with the problem of hauling its freight, and what is wanted is a locomotive which will haul twice as many tons as are now hauled. The fact that a few more tons, 50 or 60 at most, are placed on the locomotive, is entirely insignificant when compared with the entire weight of a 3,000-ton train.

*Street Railway Journal.

EUROPEAN ELECTRIC RAILWAY SCHEMES.

British and American Promoters in Berlin.—Water-power for the Swedish State Railways.

It is really wonderful how rumours are started. Only a short time ago we were told that the Germans had made arrangements for the construction of a suspended electric railway in London, and it is now said that these sentiments have been reciprocated independently by British and American promoters in relation to Berlin. When the Emperor announced his intention of abandoning the famous Grunewald as a hunting field, in order that the woods and land might form recreation grounds for jaded Berliners, it was pointed out that the project would only be of advantage if the locality could be easily reached by a rapid train service. It was thought that this object might be attained by extending the underground railway from Schoneberg *viâ* Dahlem, to the Grunewald and Wannsee, but the Schoneberg local authorities also came forward with a rival scheme for establishing such a connection. Though the preliminary works in this direction are still in progress, it is said that an English company has offered to construct and work the railway on its own account. In addition to this, it is reported that a New York company, with which American railway promoters are associated, proposes to take the matter in hand, and carry out a combined system of underground and suspended electric railways. This scheme is now under the consideration of the Schoneberg authorities, but there is little probability of external promoters being allowed a footing in Berlin, whatever may be their nationality.

The project for the construction of a suspended electric railway on the Langen system, between the north and south of Berlin, is now before the Highways Committee of the municipal authorities. It is proposed to build the railway on the circle or loop system, so that reversals of the trains at the terminal stations will not be necessary. The trains will be formed exclusively of motor cars, and the total carrying capacity of each train of three cars will be 150 persons. Including stoppages, an average speed of 21 miles an hour is contemplated, and the maximum speed has been fixed at the rate of 31 miles an hour. The scheme provides for the line being constructed for a certain distance over the viaduct of the metropolitan railway, and as the consent of the latter has to be obtained for this purpose, the Highways Committee has requested the Continental Co. for Electrical Enterprises—the promoter of the project—to submit the permission of the railway, as it would otherwise be useless to think of proceeding any further with the plans.

The Technical Commission which was appointed by the Swedish Government some time ago for the purpose of investigating the possibility of working the State railways by electricity has presented its report, which is in favour of the conversion. It is suggested that the current should, for the most part, be generated by the utilisation of the abundant supplies of water-power existing throughout the country, which are, to a large extent, owned by the State. The scheme proposes the construction and equipment of 20 power stations from which electrical energy would be distributed for the operation of the trains. The Technical Commission suggests, however, that it would be inadvisable to proceed with the scheme otherwise than in a gradual manner, and that in this way the experience gained in the working of the first railways could be turned to profit in the transformation of other lines to electric traction. It is calculated that the capital expenditure on the conversion would be very considerable.

It is announced that the French Orleans Railway Co. proposes to substitute electricity for steam locomotion in connection with the local train service between Paris and Juvisy. This decision is attributed to the favourable results which have attended the experiments made between the stations of Austerlitz and the Quai d'Orsay. With regard to the progress of the Paris metropolitan electric railway, it appears that in dealing with No. 4 section, it will be necessary to acquire the annexes to the Palais Mazarin, belonging to the Institut de France, and in appropriating the property for the purposes of the railway, the Municipal Council will have to pay compensation to the State, and also facilitate the reconstruction of the annexes. It is now proposed to endeavour to effect an amicable settlement of all the questions arising from the matter by the appointment of a Commission composed of representatives of the Government, the Institut de France, the Municipal Council, and the Prefect of the Seine.

The metropolitan electric railway in Paris is prejudicially affecting the position of the tramway companies which, with the exception of three or four overhead trolley lines, are restricted mainly to horse cars. Apart from the original tramway concessions which were granted in 1873 to the Seine Department and the City of Paris, the State directly sanctioned the construction of tramways by private individuals on subsequent occasions, principally before

the Exhibition of 1900. At that exceptional time, and in the hope of an abundant harvest, the concessionnaires accepted all the conditions which were imposed in regard to the amounts of the fares, the system of traction, and other matters, but since then they have found that under normal circumstances the fulfilment of the conditions is financially impossible. Hence the three leading tramway companies have asked for a modification of the conditions in so far as to allow of an increase in the fares, and the introduction of the trolley system on other lines in the city.

MORE ABOUT BRAKES.

Engineering took up the parable of car-brakes in a recent issue, and one's first feeling after reading the article is identical with the feelings experienced when, having become deeply interested in an article on the freckling of crocodiles during the equinoxes, one is recommended in earnest language to take somebody's panacea.

More than two-thirds of the article is taken up by a learned disquisition on the difficulties encountered in braking a car, and the hopelessness of doing this effectively by any method mentioned, while the last portion blandly states that the ideal brake from every point of view is the "Westinghouse magnetic brake."

This method of introducing a device which is on its trial is highly distasteful, and it is probable that many men, hearing of an invention for the first time in this way, might cast it from their memories as so much quackery, and so delay the more general adoption of something which might be of sterling value.

One is happy to think, after one's irritation has subsided, that the conclusions of the article are substantially correct, as one is inclined to agree that the Westinghouse brake does solve a troublesome problem very satisfactorily, so far as our present experience goes; but one is anxious to hear from those gentlemen who have had anything like a year's experience of this brake fitted to a large number of cars. In that way only shall we obtain reliable information on the two most important points after efficiency and prime cost—the cost of maintenance and the relative ease and certainty of adjustment.

To some minds the vital objection to the Westinghouse magnetic slipper brake is the belief that the rails will be worn out prematurely, on account of the necessity of using iron slippers. There is, however, an increasing number of tramway men who hold that this abnormal wear is purely a bogey, which will disappear as completely as the Cock Lane Ghost. Another objection, perhaps more weighty, is the fact that the brake depends entirely upon the integrity of the motors and the electrical connections.

The claims made for this brake which seem to be of the highest importance are: first, that the driver has but one handle to manipulate both for driving and the service or emergency stops, and he uses up an infinitely small amount of muscular energy in its application; secondly, that if the brakes are properly adjusted, it is impossible to reach the skidding point of the wheels whatever the condition of the rails may be; and last, that the car is rather held down than lifted up by the action of the slipper, this being an enormous advantage over the mechanical slipper, in that there is no tendency to derailment, and, still more important, the effective action of the wheel brakes is not diminished, or affected in any way by the application of the slippers.

To hold the car for any length of time on a grade, the wheel brakes have to be held on by the application of the usual hand-brake staff, but this need not be applied till the car has stopped dead.

The fitting of the magnetic brake does not interfere in the slightest with the action of the existing wheel-brake gear.

The great disadvantage of the rheostatic brake is that the motors get such a bad time if the brake is in constant use, whereas the magnetic brake calls for very much less current for equal braking effects.

There is no doubt that the elimination of skidding will make the driver's life a happier one, and will reduce the number of accidents arising from runaways. No one who has not actually experienced the sensation can know what an amount of determination and faith is required to release the hand-brake in order to stop the wheels skidding while the car is going fast down a grade, especially when there is another car or some vehicle on the track not far ahead.

It has been pointed out previously in the Review, and it will remain true always, that a good driver does not skid his wheels; but many drivers are not good, and it is to them, and to the undertaking that employs them, that an effective slipper brake comes as a boon. In the words of the article under consideration:—"Security does not lie solely in the brake; it depends far more upon the driver, and it is impossible to test his nerves and courage by experiments of this kind. The merit of the Westinghouse brake is that it almost eliminates the driver from the problem; it leaves him as little to do as possible under the circumstances; it makes no call upon his discretion; and it does not subject him to the stress of having to abandon his ordinary appliances for controlling his car in favour of one of the emergency type."

It is well to repeat, however, that this device has not been subjected to the only real trial, that of life, but it is finding favour quickly, and we shall not have to wait long for the required information. Meanwhile, we should be inclined to caution those who become enamoured of the brake not to commit themselves to it too deeply until they know.

ELECTRICAL CASES IN 1902.

[From a Legal Contributor.]

The progress of electricity in its application to commercial undertakings naturally leads to the creation of contracts between supply company and consumer. The breach of such contracts necessarily brings litigation in its wake; while supply companies are always exposed, in other directions, to claims which sometimes come before the Courts. It is not surprising, therefore, to find that the law reports for 1902 make mention of a number of cases of greater or less interest to the readers of the Electrical Review. Most, if not all, of these have been dealt with from time to time in these columns; but it may be convenient, at the commencement of 1903, to review the more important decisions of the last 12 months.

The development of electric tramways and the growth of the craze for municipalisation has not unnaturally led to disputes between private tramway companies and local authorities. Coming forward with full Parliamentary power to effect a compulsory purchase, the municipality has sometimes experienced a rude check at the hands of some private company which is ready to take advantage of any technicality in order to postpone the day of compulsory purchase, or otherwise tie the hands of the municipal trader. Again, the establishment or laying down of any tramway necessarily involves interference with the rights and amenities of frontagers and others; and cases involving a discussion of these rights are of comparatively frequent occurrence.

In Wilkinson and Marshall *v.* the Mayor, &c., of Newcastle (18 T.L.R., 332) an interesting point arose as to the meaning of a general clause in a tramway Act giving the company power to lay (*inter alia*) any junctions which they might consider necessary. The plaintiffs were the owners of certain property at the corner of a leading thoroughfare in Newcastle. The Corporation were empowered by an Act of Parliament to construct and work certain tramways in the city by electricity. They constructed round the corner of the plaintiffs' premises a connecting tramline, which, as the plaintiffs alleged, was not authorised by their Act, and was not shown upon the deposited plans. The near rail of this additional connecting line was within 2 ft. of the footpath in front of the plaintiffs' premises, and the plaintiffs alleged that this was not only in a source of inconvenience to them, but was in contravention of Sec. 15 of the Act, which provided that the line should be within a certain distance

(much greater than 2 ft.) from the pavement. The defendants contended that the line in question, although not specifically authorised, was in fact authorised by Sec. 7, which provided (*inter alia*) that:—"The Corporation may, if they think fit, lay down, use and maintain . . . . the tramways hereinafter described with all necessary and proper . . . . junctions . . . . and conveniences connected therewith respectively." It was contended on the part of the Corporation that the line in question was a "junction" within the meaning of this section, and that they were therefore entitled to lay it down. Mr. Justice Joyce, however, refused to accept this argument. He said:—"A junction is a joining or union, or, perhaps, in a secondary sense, the point of joining. The word is nowhere used in the Act in the sense of a junction line or railway." In the result, he came to the conclusion that the tramway had not been constructed in accordance with the powers of the Act, and held that there must be an injunction against the Corporation, compelling them to remove so much of the tramway as was not delineated on the deposited plans. Had the decision been to the contrary effect, a precedent would have been created, giving a tramway company power to lay down a piece of line not marked on their deposited plans.

In the case of the Attorney-General *v.* the Corporation of Bournemouth (18 T.L.R., 744), an important question arose as to the nature of the obligation which is put upon tramway undertakers when they are directed by statute to "substantially commence" their works before a given date. The action was brought by the Attorney-General at the relation of the Poole and District Electric Traction Co., Ltd. They claimed an injunction to restrain the defendant Corporation from constructing a certain tramway on the ground that the statutory powers had come to an end by lapse of time. It appeared that on August 6th, 1900, the plaintiff company obtained Parliamentary powers to work tramways between Christchurch and Bournemouth. On the same day the Bournemouth Corporation obtained powers to establish and work a tramway within their borough, and one of the lines so authorised ran along the route chosen by the plaintiff company. The plaintiffs, however, were prohibited from commencing to lay down their tramway at once, and their right to do so at all was to cease if the Corporation constructed their line over the same route within two years from the confirmation of the provisional order. Sec. 18 of the Tramways Act, 1870, provides that the powers given by a provisional order to promoters to make a tramway are to determine if, amongst other events, within one year from the date of the order, they are not "substantially commenced." It was decided in the above case that the "works," which under the above Section must be "substantially commenced" so as to prevent the powers from lapsing, mean physical works forming part of the works of the tramway, and do not include orders for the supply of dynamos and for the construction of electric cars for the purpose of equipping the tramway. The Court of Appeal, having found that the Bournemouth Corporation had not, in effect, substantially commenced the works within the proper time, granted an injunction restraining the Corporation from constructing the tramway. The operation of the injunction was suspended for three weeks. The moral of this case is that it is not sufficient proof of substantial commencement that orders for rails, dynamos, &c., have been placed. Physical results must be forthcoming.

The case of the Manchester Carriage and Tramway Co. *v.* the Manchester Corporation and other local authorities (18 T.L.R., 779) raised a somewhat intricate question as to what are included in the phrase, "all lands, buildings, works, materials and plant," which is commonly used in relation to the compulsory purchase of a tramway undertaking. It appeared that the tramways sought to be taken over from the Manchester Carriage and Tramway Co. by the Corporation were partly owned by the company and partly leased to them by the Manchester Corporation. The question was whether, in paying a compulsory purchase price, the Corporations were bound to pay for certain depôts or stations which had been used over the entire system. Mr. Justice Bigham, in view of the fact that the depôts and plant were suitable to and used for every part of the system, came to the conclusion that the price of the depôts should be included, and gave judgment accordingly.

One other tramway case calls for notice. We refer to the Dublin United Tramways Co. *v.* Fitzgerald (19 T.L.R., 78), which was heard in the House of Lords on November 27th. The question at issue was whether an electric tramway company are bound to lay sand upon their track in slippery weather, so as to safeguard the traffic. The plaintiff, while driving along that part of a street on which a tramway was laid, was thrown down and injured. The surface of the granite setts with which the street was paved had become worn and slippery, and the road authority had given the tramway company notice to sand that part of the street. In an action against the tramway company to recover damages for personal injuries, the jury found that the part of the pavement for which the company was responsible was slippery, and unfit for traffic; that it was a danger and annoyance to ordinary traffic, and a nuisance; that the plaintiff was injured by reason of the condition of the roadway; that the accident was not due to improper construction or improper maintenance, but to the omission of reasonable precautions, such as sanding, to prevent the pavement from becoming slippery, the company being negligent in the omission to lay sand. The jury accordingly found a verdict for the plaintiff. The House of Lords have now held that this verdict was right, declaring it to be the duty of a tramway company, under Sec. 28 of the Tramways Act, 1870, when the pavement of that part of the road for which they were responsible became worn, so as to become dangerous to traffic, to restore and maintain the road in good condition either by laying sand upon it or by other means. The importance of this case to tramway companies who use electricity as a motive power is very great. In former days when horses were used on tramways, sand between the rails was a necessity; now, however, an electric tramway company has to provide sand for the benefit of the public who drive along the track.

We hope to deal with other cases of interest to electrical engineers in a future issue.

THE RELATIONS BETWEEN COMPANIES AND LOCAL AUTHORITIES.

The development of the system of long-distance transmission of electrical energy so as to supply extensive areas from generating stations placed at the most convenient sites for obtaining cheap coal or water power, gives additional importance to the relations which should exist between electric light and power companies and municipal authorities.

It is manifestly impossible for corporations, or urban and rural district councils, to attend to more than the internal affairs of their respective localities, and no combination of local authorities is practicable which could undertake the business now being organised by the great electric power companies for the supply of the whole country in large sections.

Granting the truth of this proposition, it is essential that the municipalities should be associated with private enterprise in securing for their towns all the advantages which can be procured by the community from the modern developments in the supply of electrical energy.

The economical limit of electric power stations is not yet absolutely defined. It is clear, however, that it extends beyond the requirements of the largest cities, at all events for some time to come, for, although the use of electrical energy will naturally advance more rapidly in the future than before its advantages were so well understood, the necessary alterations must prolong the period which must elapse before it becomes the universal means for obtaining light and power.

The comparatively slow progress in the change from the old methods of illumination to that which is now admitted to be the best, is due to the practical considerations involved in changing over from the old to the new; most people would prefer to adopt electric lighting, but the alterations necessary for its adoption retard its use, and this is still more the case in the substitution of electric energy for steam power in factories, and in the working of railways and for traction purposes generally.

New manufacturing premises or railways will adopt electricity as a matter of course, just as architects and builders of houses naturally wire them for electric light where there is a chance of obtaining it, but most people hesitate to make the necessary sacrifice involved in scrapping their old plant, even although they admit that the result will eventually be advantageous and ultimately a necessity if they are to compete with modern improvements.

In considering the future methods of supplying the new agency, all these points are involved, but it is already absolutely established that small towns and communities cannot be permanently supplied with electricity from local generating stations, but must for economical reasons form part of some large scheme embracing hundreds of square miles of area.

The *possible* demand of any city has not yet been calculated, that is to say, for example, such a province of dwelling houses, manufactories, public buildings, railways and tramways, as are comprised in greater London, but if electric energy were universally adopted, would it amount to as much as would render its production on the spot more economical than if transmitted from a distance ?

The evidence given by experts before the Parliamentary Committees on the Electric Power Bills, can only be accepted tentatively, and we have still to learn what the limit of economical production from one centre, and its transmission, will be ; but it is already clear that the time has arrived for local authorities to enter into cordial relations with the private companies who are working out the great problem of supplying electrical energy under the best conditions.

It is already manifest that the action of many local authorities desirous of establishing electricity works as municipal undertakings is in the direction of taking the energy in bulk from a power company rather than generating it locally, thus admitting what is becoming so manifest—that the supply must ultimately come from a great power station.

As to whether the distribution of the electricity should not also be in the hands of the power company is not yet recognised, but there are many economical and practical reasons in favour of the control, from dynamo to consumer, being under one management.

These appear to us to be the tendencies of the supply of electric energy in the future, and local authorities who take a comprehensive view of the question should adapt their policy to meet the evident development in the great revolution which is in progress in connection with the methods of obtaining light and power.

Instead of opposing the inevitable, municipalities should enter into the closest relations with the companies whose enterprise is accomplishing the great work, welcoming them into their towns with the object of securing all the advantages obtainable at the earliest possible period.

In view of these great developments, the obstructions which the pioneers of the practical application of electrical energy meet with in this country is deplorable, for the Legislature and the municipal authorities have combined to thwart, throttle and taboo the new industry, which is of so much importance to the progress of the nation.

It is lamentable to think that narrow, selfish views and personal interests should be able to retard the rapid development of such important enterprises.

Within the last two or three years, when the advantages of a supply of electricity in small towns was already demonstrated, the action of the local authorities in opposing the necessary grant of powers was supported by a Government Department administering the Electric Lighting Acts, although the objection was boldly stated to be *the ownership by the municipality of the local gasworks*, so that in order to preserve a monopoly in gas supply the town has been deprived of the opportunity of using electricity, not only for lighting, but also for supply of power to the local factories, and the encouragement of other industries to become established in the town.

Then how difficult has been the path of the pioneers of electric traction, not merely in restrictions by the Legislature, but in the action of local authorities in obstructing the improvement, except under exactions almost amounting to blackmail.

But it is to be hoped that better counsels will prevail, and as the enormous advantages of the employment of electric power are understood, a change will take place in the relations between the companies and the local authorities, which will lead to the more speedy attainment by the public of the boon which nature and science have combined to place at their disposal.

To remove the obstructions to the electric supply industry much has to be done by the amendment of the laws which govern it as well as by the enlightenment of municipalities, but this will only be accomplished when the conditions of economical production and distribution are more fully understood, and the public thoroughly appreciate what enormous advantages they may enjoy if more freedom is accorded to the enterprising companies which have undertaken the development of a business so important in its possibilities as to amount to a prosperous revolution in the commerce of the nation.

We may have occasion to return to this subject again shortly, but in the meantime would welcome communications bearing on the subject, in order that the problems may be considered from every point of view and with all the information at the command of those practically interested in the question.

NEW PATENTS, 1903.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

7. "Improvements in and connected with incandescent electric safety lamps." F. H. HILL. January 1st.

10. "An improved automatic suspension and contact appliance, for electric arc lamps, and other apparatus, requiring to be raised and lowered." J. STEVENSON, jun. January 1st.

25. "Improvements in trolley electric tramways." G. HALL. January 1st.

47. "Improvements in the construction of current transformers used in conjunction with instruments measuring the energy in alternate current electric circuits." A. C. HEAP. January 1st.

52. "Improved contact arrangement for ships' compasses for electrically transferring the position of the needle." B. FREESE. January 1st. (Complete).

61. "Improvements relating to dynamo-electric machines." THE HON. C. A. PARSONS. January 1st.

64. "Improvements relating to controllers or current regulators for electrically-driven vehicles or machinery." G. SPARKS. January 1st.

70. "Improvements in electro-magnetic apparatus in which the armature is to be turned into different positions particularly applicable to electro-magnetic switches." SIEMENS BROS. & Co., LTD., and L. M. G. FERREIRA. January 1st. (Complete).

117. "Improvements in commutators for polyphase currents." A. HEYLAND. January 2nd.

134. "Improvements in or relating to telephone systems." I. B. BIRNBAUM. (Telephon-Fabrik Actien-sellschaft vorm. J. Berliner, Germany.) January 2 d. (Complete.)

143. "Improvements in maximum demand indicators and similar instruments." CHAMBERLAIN & HOOKHAM, LTD., and J. F. WATTS. January 3rd.

156. "Improvements in the motors, controllers, and other devices for regulating and economising electrical energy in electrically-propelled vehicles." J. S. RAWORTH. January 3rd.

157. "Improvements in and relating to telephonic apparatus." W. E. HEYS. (The Hutchison Acoustic Co., United States.) January 3rd. (Complete.)

159. "Improvements in, or in connection with, electrically-operated bells." M. H. BARBER and G. H LARMUTH. January 3rd.

162. "Electric railway system." F. MISMAHL. January 3rd. (Complete.)

174. "Improvements in appliances for electrically-controlling lifts, hoists, and the like." J. RICHMOND and R. F. CAREY. January 3rd.

175. "Means for promoting electric discharges across a dielectric gap in a circuit." A. WILLIAMS. January 3rd.

188. "Improvements in and relating to field windings of electrical machines, motors, dynamo-, and the like." W. P. THOMPSON. (Berliner Maschinenbau-Actien-Gesellschaft vormals L. Schwartzhoff, Germany.) January 3rd. (Complete.)

PUBLISHED SPECIFICATIONS, 1901.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

6,454. "A new or improved grid or electrode for retaining plumbic oxides in accumulators to prevent disintegration during charging and discharging." E. J. Clark. (Patent not yet due for sealing.) Dated March 27th, 1901.

6,587. "Improvements in watertight electric bells." A. Eckstein and H. J. Coates. Dated March 29th, 1901.

6,615. "Improvements in arc lamps." H. Bremer. March 29th, 1901.

6,617 "Means for supplying energy at stations, applicable for charging electromobiles." British Thomson-Houston Co. (C. D. Haskins.) Dated March 29th, 1901.

6,624. "Improvements in and relating to automatic magnetic circuit-breakers." W. R. Lake. (W. M. Scott, U.S.A.) Dated March 29th, 1901.

6,635. "Improvements in and relating to automatic magnetic circuit-breakers." W. R. Lake. (W. M. Scott, U.S.A.) Dated March 29th, 1901.

6,649. "Improvements in heater cut-outs and holders for electrolytic incandescent lamps." J. R. Quain and T. T. Turnbull. Dated March 29th, 1901.

6,790. "Improvements in vessels for use with electrical liquid resistances or other electrolytic solutions." H. Hirst and H. Bevis. Dated April 1st, 1901.

6,851. "Improvements in, or relating to, electric lamp shade-holders." W. Kemp. Dated April 2nd, 1901.

6,887. "Treatment of zinc chloride for electrolytic purposes." J. Swinburne and E. A. Ashcroft. Dated April 2nd, 1901.

6,893. "An improved electric distribution system." S. H. Holden. Dated April 2nd, 1901.

6,981. "Improvements in fireproof insulating ducts." E. D. Speer and H. N. Speer. Dated April 2nd, 1901.

6,998. "An electric racecourse for recreation." W. G. King. Dated April 2nd, 1901.

6,946. "Improvements in automatic telephone exchanges." H. J. Haddan. (Strowger Automatic Telephone Exchange Manufacturers: The Rookery, Chicago, Illinois, U.S.A.) Dated April 2nd, 1901.

6,947. "Improvements in the suspension of conducting wires." C. de Kando. Dated April 2nd, 1901.

6,949. "Improvements in audible electric telegraphy." R. Oxlade and W. J. W. Richardson. Dated April 2nd, 1901.

7,015. "Improvements in the suspended mechanism for electric arc lamps." Jandus Arc Lamp and Electric Co., B. M. Drake and A. D. Jones. Dated April 3rd, 1901.

7,016. "Improvements in or relating to electric arc lamps." Jandus Arc Lamp and Electric Co. and A. D. Jones. Dated April 3rd, 1901.

7,054. "Improvements in systems of electrical distribution." N. W. Storer. (Date applied for under Sec. 103 of Patents, &c., Act, 1883, September 6th, 1900.) Dated April 3rd, 1901.

7,067. "Electro-mechanical interlocking apparatus for the safe operation and control of railway signals and points." W. R. Sykes. Dated April 4th, 1901.

7,113. "Improvements in apparatus for rectifying alternating electric currents." C. M. Green, U.S.A. Dated April 4th, 1901.

7,114. "Improvements in electric regulators." British Thomson-Houston Co. (A. R. Everest, U.S.A.) Dated April 4th, 1901.

7,116. "Improved electric motor." F. de Mare. Dated April 4th, 1901.

7,136. "Telephone metering system." D. M. Bliss and N. H. Holland. Dated April 4th, 1901.

7,150. "An improved electro-magnet motor." L. H. Engelhardt and H. M. McNally and M. Gallert. Dated April 4th, 1901.

7,248. "Improvements in, and in the method of, and apparatus for the manufacture of air damping appliances for electric measurement instruments and the like." A. M. Clarke. (Hartmann & Braun.) Dated April 6th, 1901.

7,325. "Improvements in electric motors." W. P. Thompson. (C. D. Fuller.) Dated April 9th, 1901.

7,338. "Improvements in and relating to electric furnaces." C. P. E. Schneider. Dated April 9th, 1901.

7,369. "Improvements for connecting electric wires and cables." A. Wilkes. Dated April 10th, 1901.

7,371. "Improvements in or connected with terminals or bolts and nuts for use in electric batteries and connectors." H. W. Butler. Dated April 10th, 1901.

7,492. "Improvements in winding for electro-magnetic induction apparatus." H. H. Wait. (Date applied for under Sec. 103 of Patents, &c., Act, 1883, January 12th.) Dated April 11th, 1901.

7,497. "Improvements in contact boxes for the distribution of electricity." B. Cruvellier. (Date applied for under Sec. 103 of Patents, &c., Act, 1883, November 21st, A.D. 1900.) Dated April 11th, 1901.

7,524. "Improvements in electrical heating and air apparatus therefor." J. R. Quain. Dated April 12th, 1901. Patent not due for sealing.

7,547. "Improvements relating to incandescent electric lamps." H. H. Lake. (C. D. Smithers, U.S.A.) Dated April 12th, 1901.

7,553. "Improvements in electric alternate current motors." S. P. Thompson. Dated April 12th, 1901.

7,576. "Improvements in electric signalling." A. T. M. Thomson and Thomson-Davis Telephone System. Dated April 12th, 1901.

7,617. "An improved device or apparatus for threading sewing needles." J. Vaughan-Sherrin. Dated April 13th, 1901. Patent not due for sealing.

7,629. "Improvements in and relating to electric batteries." I. Celestre and F. Gondrand. Dated April 13th, 1901.

7,641. "Improvements in and relating to telephone exchange systems." W. F. Smith. Dated April 13th, 1901.

7,676. "Improved guide for placing trolleys on trolley wires." H. Hancock and D. Walters. Dated April 15th, 1901.

7,701. "Improvements relating to means for controlling the trolley arms of electric tramcars driven from overhead wires." P. D. Milloy and International Trolley Controller Co. Dated April 15th, 1901.

7,788. "Improvements in controllers for electric motors." British Thomson-Houston Co. (W. B. Potter, U.S.A.) Dated April 16th, 1901.

7,796. "An improvement in commutators for electric meters and the like." C. D. Abel. (Campagnie Anon. Continentale pour la Fabrication des Compteurs à Gas et Autres Appareils). Dated April 16th, 1901.

7,834. "Improvements in insulators for electric conductors." K. T. Bennett and J. T. Johansson. Dated April 16th, 1901.

7,855. "Improvements in means or arrangements for regulating the excitations of alternating current machines." O. T. Blathy. Dated April 16th, 1901.

7,958. "Novel or improved means for working or controlling semaphore or other signalling or indicating apparatus in connection with electric tramway systems, also applicable for other purposes." J. Wilkinson. Dated April 18th, 1901.

7,959. "Increasing the economical efficiency of electric incandescent lamps." E. Bushe. Dated April 18th, 1901.

7,966. "Improvements in or relating to electro-pneumatic controlling systems." E. B. Hill. Dated April 18th, 1901.

8,015. "A direct acting combined magnetic regulator and brake for electric arc lamps." J. Lenderyou, T. S. M. Wyatt. Dated April 18th, 1901.

8,110. "Improvements in means for raising, lowering and supporting arc lamps and for electrically connecting them with the mains." H. T. Harrison. Dated April 19th, 1901.

8,110a. "Improvements in electric couplings and switching apparatus." Dated April 19th, 1901.

8,153. "An improved process for the purification of aluminium." W. B. Johnson. Dated April 20th, 1901.

8,196. "Improvements in sockets or holders for incandescent electric lamps." J. W. H. Uytenbogaart. Dated April 20th, 1901.

8,280. "Improvements in or relating to accumulators or secondary batteries." R. Fortun and E. Semprun. Dated April 22nd, 1901.

8,306. "Improvements in current collectors for use on electric railways or tramways." T. O. Woodward and E. H. Torr. Dated April 23rd, 1901.

8,395. "Improvements in telephone transmitters." C. C. Hughes. Dated April 23rd, 1901.

8,437. "Improvements in the manufacture of vulcanised electric cables." E. A. Claremont. Dated April 24th, 1901.

8,475. "Improvements in brush-holders for dynamo-electric machinery." Lancashire Dynamo and Motor Co. and A. P. Wood. Dated April 25th, 1901.

8,478. "An automatic shunt for protecting electric arc lamps." A. Eckstein and A. E. Angold. Dated April 25th, 1901.

8,515. "Improvements in portable chaff-cutters." V. A. Arcioni. Dated April 25th, 1901.

8,598. "Improvements in or relating to accumulators or secondary batteries." G. F. W. Kloth, O. H. G. Bunning and J. G. L. D. Kunhardt. Dated April 26th, 1901.

8,629. "An improved traversing ladder." R. P. Wilson. Dated April 26th 1901.

8,648. "Improved automatic electric exchange apparatus." W. L. Wise. (American Machine Telephone Co., Piqua, Ohio, U.S.A.) Dated April 26th, 1901.

8,658. "Improvements in starters for electric motors." W. R. Ridings and Veritys, Ltd. Dated April 27th, 1901.

8,803. "Improvements in safety devices for electric measuring instruments." A. V. Arcioni. Dated April 29th, 1901.

8,890. "Improvements relating to printing electric telegraphs." J. E. Heimerdinger. (Drawings to specification.) Dated April 30th, 1901.

8,906. "Improvements relating to the manufacture of gas." L. Maiche. Dated April 30th, 1901.

8,920. "Improvements in electric switches." J. E. Spagnoletti. Dated April 30th, 1901.

8,956. "Improvements in the construction of dynamo-electric machines and electro-motors." E. S. G. Rees. Dated May 1st, 1901.

8,962. "Improvements in switch apparatus for use in a surface contact system of electric traction, and in operating switches used in such system." T. H. Parker. Dated May 1st, 1901.

8,964. "Improved means for use in operating from a car or train switches employed with a surface contact system of electric traction." T. H. Parker. Dated May 1st, 1901.

8,965. "Improvements in or in relating to skates or contact makers carried by cars for use in a surface contact system for electric traction." T. H. Parker. Dated May 1st, 1901.

8,967. "Improvements in the method of forming armature coils for dynamo and electric motors, and in apparatus for use therein." T. H. Parker. Dated May 1st, 1901.

8,985. "An improved thermo-electric battery." L. Benier. Dated May 1st, 1901.

8,997. "Improvements in apparatus for governing electric currents. A. W. Gattie. Dated May 1st, 1901.

9,011. "Improvements in the electro-deposition of metals for the manufacture of compound wire bars and the like, and in apparatus therefor." R. D. Sanders. Dated May 1st, 1901.

9,056. "Improvements in connection with the electric insulation of cotton-covered cables or wires." E. A. Claremont and C. J. Beaver. Dated May 2nd, 1901.

9,211. "Improvements relating to the insulation of electrical conductors and the like and to compounds therefor." H. H. Lake. (O. T. Hungerford, U.S.A.) Dated May 3rd, 1901.

9,217. "Improvements in electric fuses or cut-outs." J. Y. Johnson. (D. and W. Fuse Co., U.S.A.) Dated May 3rd, 1901.

9,265. "Electric arc lamp." T. W. Young. Dated May 4th, 1901.

9,276. "An improved electric heating body." I. Timar. Dated May 4th, 1901.

9,279. "Improvements in and connected with the trolley poles of electric cars and the like." P. McCullough and T. Blaney and R. Baron. Dated May 4th, 1901.

9,295. "Improvements in means for preventing the oscillation of alternators connected in parallel." R. Haddan. Dated May 4th, 1901.

9,303. "Improvements in electric transformers." G. Berry. Dated May 4th, 1901.

9,350. "Improvements in and relating to electric furnaces for heating or re-heating objects in a predetermined degree." A. Grobet. Dated May 6th, 1901.

9,384. "Improvements in electric arc lamps." W. C. Johnson and W. B. Esson. Dated May 6th, 1901.

9,388. "Improvements in electric arc lamps." Helios Upton Co. and T. Spencer. Dated May 6th, 1901.

9,512. "Improvements in solenoid and other electric coils." J. A. Heany. Dated May 7th, 1901.

9,527. "Improvements in connection with electrical fuses" J. Y. Johnson. Dated May 7th, 1901.

9,610. "Improvements in electrical exercising machines." H. H. Lake. Dated May 8th, 1901.

9,611. "Improvements in trolley leads for use in connection with the overhead system of electric traction." A. Metcalfe. Dated May 8th, 1901.

9,675. "Improvements in or relating to arc lamps." Jandus Arc Lamp and Electric Co. and A. D. Jones. Dated May 9th, 1901.

9,676. "An improved electric smelting process and apparatus to be used therein." British Aluminium Co. (A. H. Cowles, U.S.A.) Dated May 9th, 1901.

9,679. "Improvements in or relating to the manufacture of various articles from plastic substances." F. Reddaway and M. M. Dessau. Dated May 9th, 1901.

9,692. "Improvements in sectional conductor systems for electric traction railways and the like." C. Haggenmiller. Dated May 9th, 1901.

9,740. "An improved ceiling switch." A. Reckenzaun. Dated May 10th, 1901.

9,745. "An improvement in or relating to electric current circuit breakers." E. F. Moy and P. H. Bastie. Dated May 10th, 1901.

9,769. "Improvements in current collectors or contact shoes for electric railways." H. H. Lake. Dated May 10th, 1901.

9,781. "An improved insulator for use with bracket suspenders of overhead trolley systems and the like." R. C. Quin. Dated May 11th, 1901.

9,801. "Improvements in electric telegraphy." S. G. Brown. Dated May 11th, 1901.

9,829. "Improvements in automatic electric circuit-breakers." British Thomson-Houston Co. and E. B. Wedmore. Dated May 11th, 1901.

9,882. "Improvements in and relating to electric arc lamps." G. M. Lane. Dated May 13th, 1901.

9,883. "Improvements in controllers for electric motors." A. O'N. Fox. Dated May 13th, 1901.

9,903. "Improvements in obtaining volatile elements from their ores and compounds." British Aluminium Co. (A. H. Cowles, Cleveland, Ohio, U.S.A.) Dated May 13th, 1901.

9,916. "Improvements in collecting brush-holders for dynamo-electric machines." W. H. Flood and A. E. Honey. Dated May 13th, 1901.

9,925. "Improvements in the working of induction motors and other apparatus with alternating or pulsating currents." H. C. Newton and R. S. Wright. Dated May 13th, 1901.

9,959. "Improvements in incandescent electric lamp globes." E. Böhm. Dated May 14th, 1901.

9,987. "Improvements in electric cables." J. D. Gould. Dated May 14th, 1901.

10 053. "An improved trolley wheel for overhead wire systems of electric traction." E. M. Munro, H. Brecknell and H. I. Rogers. Dated May 15th, 1901.

10,062. "Improvements in moving coil electrical measuring instruments." A. Eckstein and F. Panter. Dated May 15th, 1901.

10,088. "Improved apparatus for treating affected parts of the body with heat, light or electricity in certain cases simultaneously." I. Timar. Dated May 15th, 1901.

10,102. "Improvements in electrical switches." Messrs. Evered & Co. and C. Holt. Dated May 15th, 1901.

10,120. "Improvements in wireless telegraphy." A. Muirhead. Dated May 15th, 1901.